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Remote Specialist Consultation and Continuing Medical Education Pilot Project

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1. Executive Summary

1.1 Overview

The *Remote Specialist Consultation and Continuing Medical Education System Pilot Project* tested the viability and acceptability of using telemedicine to provide specialists services and continuing medical education to rural communities in Nova Scotia. Programs were developed and technology was installed to trial a Continuing Medical Education (CME) program, and a dermatology and radiology specialist support system. The objective was to assess the educational, clinical, operational, financial, and technical viability of the telemedicine application. The project was funded by the Nova Scotia Department of Health and was conducted during 1996.

The telemedicine program tested during this pilot project was found to be educationally, clinically and technically viable. Merging the requirements of education and training, clinical programs and administration requires a program management infrastructure if the pilot project model is to be expanded to an operational system. This will facilitate operational and financial efficiencies which will be system wide, and will ensure long term planning, focus and viability.

Rural healthcare providers and rural patients found the system presented in the pilot project to be both highly acceptable and desirable. One hundred percent of patients who were exposed to the system felt that it was an advantage to their community. Most healthcare providers felt that the system increased their access to education and training resources and reduced their feelings of isolation.

1.2 Background

The goal of this pilot project was to assess the educational, clinical, operational, financial, and technical viability of the application of new technologies techniques in providing continuing medical education and clinical specialist support to rural centers.

This project was conducted as a partnership of:

- Nova Scotia Department of Health;
- Continuing Medical Education Department of the Faculty of Medicine of Dalhousie University in Halifax;
- Cape Breton Regional Hospital in Sydney;
- Guysborough Memorial Hospital in Guysborough;
- Northside General Hospital in North Sydney;
- Eastern Shore Memorial Hospital in Sheet Harbour;
- Queen Elizabeth II Health Sciences Centre Radiology Department in Halifax;
- Queen Elizabeth II Health Sciences Centre Dermatology Department in Halifax;

- TecKnowledge Healthcare Systems of Dartmouth; and
- MT&T in Halifax.

1.3 Continuing Medical Education

A system of providing Continuing Medical Education (CME) from the Dalhousie Medical School in Halifax was tested to a regional healthcare center in Sydney; a small town hospital in North Sydney; and rural facilities in Sheet Harbour and Guysborough. The project began in January 1996 and was completed in June 1996.

Twelve individual programs were developed and broadcast to two of four receiving sites at a time - for a total of 24 broadcasts. There were 332 attendees at the sessions - 269 physicians, and 53 other healthcare professionals. A structured evaluation was done before the pilot program began, after each session, and at the end of the pilot project.

Rural physicians had a high degree of acceptability for this means of attending CME sessions. They highly valued the system as they are more isolated and faced additional barriers to attending traditional CME sessions. It was also found that the sessions fostered interdisciplinary learning and team building within the healthcare team as other team members (nurses, social workers, etc.) were able to attend the sessions.

The small town physicians had a slightly lower degree of acceptability than rural physicians due to the availability of other CME options. They still valued the sessions as they found them more accessible with reduced loss of practice time. The physicians in the regional centre in Sydney had a lower percentage of attendance at the sessions, but still found them acceptable as a means of accessing CME.

Session presenters found the system highly acceptable as a means of conducting CME sessions. It was strongly felt that the interaction between faculty and participants was effective and valued.

An assessment of the operational costs (room rental, long distance, conferencing bridge, etc.) of conducting sessions via videoconferencing showed the costs were less than those of the traditional visiting professor sessions.

The overall conclusion was that this technology is a very viable means of providing CME - particularly to rural sites.

1.4 Radiology

A system of providing x-ray interpretation from the Queen Elizabeth II Health Sciences Centre in Halifax to rural facilities in Sheet Harbour and Guysborough was tested. The technical and clinical evaluation phase began in January 1996, with the operational phase beginning in September 1996 and concluding in December 1996. Both scheduled and unscheduled interpretations were part of the program.

In the technical and clinical evaluation the system was found to meet the teleradiology guidelines published by the American College of Radiologists (ACR), and the Canadian Association of Radiologists (CAR). Films were digitized by a scanner at the rural sites. The digital files were transmitted to the QEII radiology department via a network and were interpreted by the radiologist on a gray-scale monitor. A total of 548 film interpretations were conducted for Guysborough and 260 for Sheet Harbour.

To determine the diagnostic accuracy of the system, a proportion of the original films were read and the reports compared with those for the digitized images read during the pilot study. This "double-read" comparison process was to determine the degree to which image detail was lost or changed in the digitisation, transmission and image re-creation processes. Double reading of films showed differences in 4.3% of cases.

The second phase of the comparison study required re-reading of both the digitized images and the original films for those examinations for which discrepancies were found. The purpose of this phase was to determine if the identified discrepancies were caused by loss of detail or changes attributable to the digitisation process, or if they were caused by other factors - such as reader error or reader variation within normal limits.

A total of four discrepancies of 352 double-reads were noted between the digitized image and the original radiograph. In two of these cases the diagnosis was unaffected by the loss of detail. In another the digitisation actually appeared to accentuate (or enhance) the lesion image rather than to blur it. The other discrepancies were concluded to be due to reader variation in interpretation of minor details which would not affect diagnosis.

Thus the number of "misdiagnoses attributable to digitisation" was four. This represents a rate of variation of 1.1%. Using binomial probabilities, at a 95% confidence interval for the rate in the underlying process, the rate of variation in the underlying process is no higher than 3%, given that the observed rate variation rate was 1.1%.

The consulting radiologist believes that teleradiology is a reliable and accurate means of conducting routine radiological examinations. It was determined that a second high resolution monitor would make comparison of current and previous films more efficient and effective, and that image viewing should be to a 12-bit depth to increase the number of shades of grey available. It was also noted that the quality of the original films affects the quality of the interpretation, so a quality assurance program would have to be implemented at all teleradiology sites.

In general , rural physicians and x-ray technologists found this system acceptable. At one site, patient reports were generally received sooner.

Five emergency cases were received during the pilot. In three of these, the immediate response of the radiologist resulted in the patient not being transported to the regional healthcare facility for further assessment. This resulted in considerable reduction of the stress to the patient, the patient's family and to the rural healthcare providers treating the patient. This also resulted in a cost savings of ambulance transport costs, and possible reduction of hospital admission and inpatient days.

In summary, rural access to routine radiology services would be improved by use of a teleradiology service. This is very dependent on the particular circumstances of a rural facility. In emergencies, access to radiological consultation is seen to be increased substantially. This will have a substantial affect on both the patient and rural healthcare provider, and will reduce the costs of emergency transport. Further savings could be realized in reduction of patient admission and inpatient days.

1.5 Dermatology

A system of providing access to dermatology diagnostic services from the Queen Elizabeth II Health Sciences Centre in Halifax from rural facilities in North Sydney, Sheet Harbour and Guysborough was developed and tested. The project began in May 1996 and concluded in August 1996. A scheduled Teledermatology Clinic was conducted at each rural site and unscheduled dermatology services were provided upon request.

Sixty-six consultations were conducted under this program - fifty-five new patients, and eleven return visits. There were eighteen patients from Guysborough, fifteen from Sheet Harbour, and twenty-two from North Sydney. Twenty-eight of the patients were female and twenty-seven were male. Ages ranged from 18 months to 89 years, with eleven patients under the age of 16 years.

Forty-one different diagnoses were made. Four of the fifty-five patients were seen in follow-up office visits. At the traditional visit the telemedicine diagnosis was confirmed. Seven of fifty-five patients were requested to have skin biopsies performed. Three of the seven biopsies confirmed that the teledermatology diagnosis was accurate. One of the seven confirmed that the diagnosis had been included in the original differential diagnosis. Two were over-diagnosed as possible skin cancers but were found to be benign. The final biopsy condition was unknown at the time of this report. Five of fifty-five patients were requested to have blood work. Three of the fifty-five patients had to travel to Halifax for patch tests. All of these investigations would have been requested if the patient had been seen in the traditional office consultation.

Five patients were seen under unscheduled or urgent conditions. The health care status of these patients was improved dramatically as a result of being seen within 24 hours.

The dermatology specialist concluded that this is a satisfactory way to see patients and that patient-physician communication was not compromised. It was also determined that the accuracy of diagnoses (confirmed by biopsies, blood work, patch tests and "live" visits) was similar to the accuracy of "live" consultations.

The referring physician in the rural communities also had a high degree of acceptability for the teledermatology clinics. All agreed that this service was of value to physicians in rural practice, and that attending the consultation provided valuable CME.

There was a high degree of patient acceptability, with one-hundred percent of patients stating that this service was of value to them and their community. Patients also felt that patient-physician communication was not compromised in visiting the specialist in this manner. Rural patients felt that this was a cost savings for them - as they did not have to travel to Halifax. In addition, most patients felt that this contributed to their overall health as they were able to access services in a timely and less stressful manner.

1.6 Technical Assessment

One of the objectives of this project was to assess the capabilities of the technology and telecommunications in providing CME and clinical services. In particular, this pilot project was to assess the ability of a multipurpose telemedicine workstation in:

- presenting the participants with enough information to learn from broadcast CME sessions, and
- presenting specialists with sufficient diagnostic quality information so that they are able to assess a patient's condition and make recommendations as to a patient's care.

The rural systems were based on computer technologies integrated with high performance videoconferencing. All sites found the videoconferencing easy to use once training of users was undertaken at each site. Using the system, all users were able to successfully participate in CME and in the teledermatology clinics with minimum difficulty.

It was determined that the systems must be designed to be very rugged and easy to move around the facility and set-up. The system components - monitor, camera, microphone and speakers - must be of high quality to present the participants with the most realistic images and sounds. Lighting, room setup and background colours were found to be significant factors in successful conferencing - particularly in clinical situations. This was found to influence the degree of acceptability of the system by both patients and clinicians.

The user interface must be simple and intuitive as most users were not frequent users, and many were not highly computer literate. During the pilot project, workflow processes were determined and automated where ever possible to reduce the number of steps required to perform a task.

In teleradiology, management of the digital information is an issue which requires careful assessment and planning before system implementation. The pilot project did not test storage and archiving of information for future retrieval, and management of the technology (i.e. computer storage and communications) was a significant effort for all involved. Future systems should carefully assess memory, communications and display requirements.

Overall, the system was found to be technically viable. The installation of a single multipurpose telemedicine workstation was found to be a viable option for provision of education and clinical services. In addition, it should be noted that the same workstations could also be used for administrative purposes (i.e. meeting, interview, etc.).

1.7 Operational Assessment

The system was also assessed for operational viability in the rural communities. In each of the programs, requirements for operational and support resources were assessed. Also, as these were multipurpose workstations, the need to manage inter-program requirements was determined.

Over the year long pilot project it became clear that any telemedicine program must be managed in a program management infrastructure to ensure most effective and efficient use of the technologies and the clinical and support resources. This is particularly important to the rural facilities who will have a single access point to the system.

In all phases of the pilot project it became evident that technical and administrative support was necessary for the programs to flow smoothly. In particular:

- CME - support was needed to book session rooms, the conferencing bridge, prepare and circulate advertising, and to set-up equipment and facilities;
- teleradiology - support and structure was needed to manage patient information, planning and scheduling of specialist support and consulting resources, and management of the technology and telecommunications; and
- teledermatology - support was needed to manage patient booking, and system scheduling and set-up at all sites.

The program management infrastructure recommended includes a Telemedicine Advisory Board and Telemedicine Management Team. The Telemedicine Advisory Board would be responsible for endorsing the strategic plan, approving policy and ensuring effective key relationships. The Telemedicine Management Team would provide the overall management structure and facilitate the implementation and coordination of telemedicine programs.

1.8 Financial Assessment

Costs of a telemedicine program are relatively easy to identify and rationalize, but cost savings are difficult to both identify and estimate. This pilot project demonstrated that justifying the total costs of implementing a telemedicine program from operational savings alone will be difficult. Using technologies which are multipurpose shares the fixed costs among a number of educational and clinical applications.

The actual costs of the pilot project were divided into project costs (those associated with the management of a pilot project) and program costs (those associated with an ongoing telemedicine program). In assessing the viability of an operational telemedicine program, the project costs for this pilot project were not considered.

It was found that that variable operational costs of providing CME using videoconferencing technologies were significantly less than those of providing traditional CME programs. This did not include the savings to rural physicians and facilities by reducing the requirements for travel and time away, or the capital and fixed operating costs of the workstations. Using the pilot project model (2 receiving sites per session), it was found that twelve CME sessions per site would need to be held per year to recover 25% of the capital and fixed costs of installing this system in a rural facility. As it is estimated that a minimum of 5 sites per session would receive CME, the operational savings per session would increase as the program expands.

The operational savings realized in providing teleradiology services were found to be relatively small in comparison to the capital and fixed operating costs of the service. Using the model provided in the pilot project, a significant number of emergency admissions or transports would need to be avoided to recover these costs. It is difficult to estimate the overall financial impact of providing more rapid turn-around of radiology reports but it is projected that long term system-wide savings would result from more immediate and accurate treatment of patients.

The patient realized the largest savings in the teledermatology services. This was due to reduced requirements for travel. Using the pilot project model, the estimated costs of providing a two hour teledermatology clinic were estimated at $33.70 for the consulting institution, and $159.70 for the referring institution. This included an estimate of the amortized fixed costs of the workstations.

A telemedicine program effectively moves the provision of clinical services from an urban community to a rural community. This will have a financial impact on the rural community and the healthcare facilities in those communities. It is difficult to determine the savings that will result from more immediate response to clinical problems, and better access to specialist services by rural patients. This should improve the health status of those communities and reduce the overall long term healthcare costs.

1.9 Conclusions

The pilot project was successful in its goal of assessing the educational, clinical, technical, operational and financial viability of a telemedicine program in providing support to rural communities. The telemedicine program tested during this pilot project was found to be educationally, clinically and technically viable. It was determined that an expanded telemedicine program needs to have a program management infrastructure to ensure long term planning, focus and viability.

The major beneficiaries of a telemedicine program were found to be healthcare providers and patients in rural communities. This was due to educational and clinical services delivered directly to the community, instead of the community members having to travel to access those services. This will improve the ability of those communities to effectively manage their healthcare needs and will assist in improve the health status of the surrounding area.

2. Overview

2.1 Purpose of Report

This report summarizes the results of a telemedicine pilot project sponsored by the Nova Scotia Department of Health. This project tested the appropriateness of videoconferencing and other computer-based technologies in providing Continuing Medical Education (CME) and dermatology and radiology specialty support to selected rural communities in Nova Scotia. The project was conducted during 1996.

The goal of this pilot project was to assess the educational, clinical, technical, operational, and financial viability of this solution in a reformed Nova Scotia healthcare system.

2.1.1 Definitions

For the purposes of this report the following definitions are used:

- A **specialist** or **consulting** site is defined as one in which a specialist or clinical consultant is located. This is typically found in a more urban environment where there is a higher concentration of population.
- A **referring** site is defined as a location which is distant from the specialist or consulting site from which the clinical service is being provided. This may be in an urban or rural environment and is defined only by the need to access expertise elsewhere.
- A **rural** site is defined as a site with a population of less than 10,000.

2.2 Project Description

This project was established to develop and test a system to provide Continuing Medical Education (CME) and remote specialist support to rural communities in the province of Nova Scotia. In particular, the project tested the following components of a system:

- providing CME from the Dalhousie Medical School in Halifax to a regional healthcare center in Sydney, to a small town hospital in North Sydney, and to rural facilities in Sheet Harbour and Guysborough;
- providing teleradiology film interpretation and emergency radiology interpretation services, from the Queen Elizabeth II Health Sciences Centre in Halifax to rural facilities in Sheet Harbour and Guysborough; and
- providing teledermatology diagnostic services from the Queen Elizabeth II Health Sciences Centre in Halifax to rural facilities in North Sydney, Sheet Harbour and Guysborough.

2.3 Project Partners

This project has been conducted as a partnership of the following entities:

- the Nova Scotia Department of Health;
- the Continuing Medical Education, Faculty of Medicine, Dalhousie University in Halifax;
- the Cape Breton Regional Hospital in Sydney;
- the Guysborough Memorial Hospital in Guysborough;
- the Northside General Hospital in North Sydney;
- the Eastern Shore Memorial Hospital in Sheet Harbour;
- the Queen Elizabeth II Health Sciences Centre Radiology Department in Halifax;
- the Queen Elizabeth II Health Sciences Centre Dermatology Department in Halifax;
- TecKnowledge Healthcare Systems of Dartmouth; and
- MT&T of Halifax.

3. Background

3.1 Overview

Nova Scotia is currently undergoing extensive reform of its healthcare system. A major part of this reform process is a movement toward more community-based provision of care. Some of the prevailing healthcare trends are:

1) to resolve access and quality issues for distant, special, and underserved populations;
2) to deliver the same service level at a reduced cost;
3) to achieve significant clinical outcomes; and
4) to enable and support professional relationships between primary, secondary and tertiary clinicians.

Recent improvements and developments in technology and telecommunications can enable new healthcare delivery mechanisms. This pilot project tested the application of these new developments in specific educational and clinical areas.

3.2 Rural Site Issues

3.2.1 Coverage and Lifestyle Concerns

Rural communities require the same twenty-four hour availability of healthcare services as urban communities. In rural communities, however, there are fewer providers to share the responsibility for providing twenty-four hour coverage. Regular night time call responsibilities, in addition to full time responsibilities during the day in a clinic or hospital, can place a significant burden on healthcare providers. Inadequate time off and regular interruptions of personal time also contributes to professional dissatisfaction. All of these factors make it difficult for many rural communities to recruit and retain healthcare professionals.

3.2.2 Access to Continuing Medical Education

There is increasing emphasis on providers of continuing medical education (CME), and other healthcare education providers, to deliver timely and accessible programs. This has become increasingly difficult as physicians and other allied health professionals have less time available for continuing education activities, and are less able to leave their geographic areas of practice due to coverage considerations. To address this issue, the Continuing Medical Education Department of the Faculty of Medicine at Dalhousie University has traditionally delivered education programs to regional and rural centers with the help of local expertise and through a "visiting professor" program.

Healthcare reform is placing additional burdens on the continuing medical education system - as both the "students" and the "professors" have less time to travel. In addition, the need for training has increased as patients with more severe conditions are returning to or staying in their communities.

3.2.3 Access to Specialist Services

Residents of rural areas are often forced to travel long distances to access specialist care in more urban centers. Although many larger facilities have developed traveling clinics in certain specialty areas, these clinics may not be in the area when a patient requires specialist advice. Even under normal circumstances, these clinics result in follow-up visits where the patient must travel to the urban site.

Rural residents would benefit from accessing specialist care in their own communities. Rural physicians would also gain more specialized knowledge by interacting with a specialist on a routine basis.

3.3 Videoconferencing in Education and Training

Videoconferencing has been demonstrated to be very effective in delivering many kinds of CME - both on general interest and specific topics (see literature review in Section 5). This has been enhanced by integration of medical images, demonstration videos, or other techniques into the training process. Videoconferencing also supports the development of problem-based learning and "just-in-time" training applications.

3.4 Telemedicine

Telemedicine involves the use of technologies and telecommunications to provide medical services to sites that are at a distance from the provider. The concept encompasses everything from the use of standard voice telephone service to high-speed, wide bandwidth transmission of digitized signals in conjunction with computers, fiber-optics, satellites, and other sophisticated equipment.

The technology of telemedicine has evolved significantly over the last 10 years - and is becoming more accepted as a means for clinicians to treat patients at a distance. The clinical and operational aspects of telemedicine, which are very dependent on situations and circumstances around the provision of healthcare, are less understood.

Some examples of clinical applications of currently available telemedicine systems are:

- to digitize and transmit high resolution, full motion analog video images (e.g. cardiac angiograms) to consulting specialists for immediate joint review or for deferred review;
- to capture and transmit digital images (e.g. radiographs, retinal scans) to consulting specialists for immediate joint review or for deferred review;

- to conduct live videoconferencing sessions with consulting specialists to discuss patient histories and develop care plans;
- to review and diagnose ultrasound and echocardiology exams as they are being performed, and interact with the technicians conducting the study to optimize the exam as well as to provide training and QA services; and
- to conduct comprehensive, real-time patient interviews, evaluations and diagnoses at off-site locations (i.e. home, extended care facilities, family practice offices).

3.4.1 Teleradiology

Teleradiology is the most researched and most practiced form of telemedicine. The American College of Radiology (ACR) defines teleradiology as "the electronic transmission of radiological images from one location to another for ... interpretation and/or consultation". This area of telemedicine has been extensively tested and validated in a number of studies and trials.

In September 1994, the ACR Council approved a standard for teleradiology. The standard defines goals, personnel qualifications, equipment guidelines, licensing, credentialing, liability, communications, quality control, and quality improvement measures. In late 1995, this standard was amended to include data management as an integral component of the teleradiology program. The Canadian Association of Radiologists (CAR) has also adopted a set of teleradiology guidelines. These are substantially based on the ACR standard.

3.4.2 Teledermatology

Teledermatology is a more recently developed telemedicine technology. Traditionally teledermatology has involved the use of digital camera to capture dermatology images and forward them to a distant site for interpretation. This project augments that capability with videoconferencing so that the dermatologist can interact with the patient and local care provider.

At present there are no widely accepted standards for teledermatology.

3.5 Project Partners

The project has been conducted through a collaboration of healthcare providers, healthcare policy decision makers, and private industry providers of technical and telecommunications solutions. The following is a brief background on each of the partners, and their broad objectives in participating in this project.

3.5.1 Nova Scotia Department of Health

Nova Scotia has a universally funded public healthcare system. The Nova Scotia Department of Health (NSOH) funds healthcare delivery for the province. The mission of the Department of Health is to promote, maintain and improve the health status of Nova Scotians at a cost that is sustainable for Nova Scotia. In this role the NSDOH determines healthcare policy and sets standards for the delivery of care in the province.

3.5.2 Dalhousie University Faculty of Medicine Continuing Medical Education

The Dalhousie Medical School, founded over 125 years ago, is the fourth oldest of Canada's sixteen medical schools. With its main center in Halifax, the Dalhousie Medical School extends to the neighboring provinces; New Brunswick and Prince Edward Island. This Maritime region has many primary, secondary and tertiary care hospitals, and all of these serve to teach Dalhousie's medical students.

Over 1100 full time and part time faculty teach 350 undergraduate (MD) students, 375 postgraduates (residents), students in the combined MD/PhD program, and students from other faculties like Dentistry, Nursing, and Occupational Health.

The Faculty of Medicine has provided continuing medical education opportunities to Maritime physicians for over 70 years and Dalhousie Continuing Medical Education, a full academic unit of the Faculty, was established in the late 1950's. The mission of Dalhousie CME is "to enhance the provision of quality health care through research and facilitation of lifelong learning". The major teaching programs include the Community Hospital Program, Short Course Program, Management Program for Clinical Leaders and Clinical Traineeships. Increasing emphasis is being placed on providing support to physicians in their communities through distance and community-based education, small-group problem-based learning, and development of skills in areas such as computers in medical practice.

Dalhousie CME re-evaluates its program of delivering off-site Continuing Medical education programs on an ongoing basis. During this process they have investigated alternate program delivery models based on videoconferencing technologies. In support of this activity the Faculty of Medicine had developed, equipped, maintained and staffed a fully functioning broadcast studio in the Sir Charles Tupper Medical Building. This site uses room-based videoconferencing equipment to broadcast to external sites. The main purpose behind the development of this site has been for CME, but it is also anticipated that the site will also be used for administrative purposes and to facilitate information exchange between researchers.

3.5.3 Cape Breton Regional Hospital

The Cape Breton Regional Hospital is a regional referral center in Sydney. It serves Nova Scotians who reside in the industrial Cape Breton area - a catchment area of approximately 157,000 persons. Sydney is approximately 460 kilometers from Halifax - the site of the major tertiary centers.

It is also a referral center for the surrounding rural areas and has clinical programs in most specialist areas. In 1996, the facility had 300 beds and a staff of approximately 150 physicians.

3.5.4 Guysborough Memorial Hospital

The Guysborough Memorial Hospital in Guysborough is a rural healthcare facility which provides healthcare services to a portion of the population of Guysborough County - with a catchment area of approximately 3200 persons. Guysborough is approximately 70 kilometers from the nearest regional referral center in Antigonish, and 280 kilometers from the major tertiary centers in Halifax. In 1996, the facility had ten inpatient beds and a staff of three physicians.

3.5.5 Northside General Hospital

The Northside General Hospital in North Sydney is a small town healthcare facility which provides healthcare services to a portion of the populations of North Sydney, Sydney Mines and Bras D'Or - with a catchment area of approximately 27,000 persons. North Sydney is approximately 30 kilometers from the nearest regional referral center in Sydney, and 410 kilometers from the major tertiary centers in Halifax. In 1996, the facility had sixty-two inpatient beds and a staff of approximately twenty-five physicians.

3.5.6 Eastern Shore Memorial Hospital

The Eastern Shore Memorial Hospital in Sheet Harbour is a rural healthcare facility which provides healthcare services to a portion of the population of the eastern shore - with a catchment area of approximately 5900 persons. Sheet Harbour is approximately 120 kilometers from the major tertiary centers in Halifax. In 1996, the facility had twenty inpatient beds and a staff of four physicians.

3.5.7 Queen Elizabeth II Health Sciences Centre Radiology Department

The QEII Radiology group in Halifax consists of thirty radiologists and three medical physicists who have expertise in all areas of diagnostic imaging. The radiology group at the QEII Health Sciences Centre has a long range commitment to investigate and support the provision of teleradiology to rural locations for the following reasons:

1) It provides immediate access to radiographic interpretation when necessary. This will lead to direct cost saving and will impact on local patient care in the following ways: additional examinations may well be performed locally rather than sending patients to regional or tertiary centers for next step follow-up; improved technical supervision and consultation can improve quality of examinations, thereby reducing repeat examinations; improved consultative services for local physicians can lead to more appropriate examinations being requested; and consultation can result in more informed decisions with respect to medical treatment, reducing non-essential hospital admissions and unnecessary out-referrals to regional centers.
2) It can provide a more efficient radiology service to underserved areas.

3.5.8 Queen Elizabeth II Health Sciences Centre Dermatology Department

The QEII Dermatology Department has one full time and eight part-time dermatologists. The department has four inpatient beds which, in 1996, had eighty-seven admissions. In 1996, the department treated 1268 new patients and 3877 return patients.

Most dermatologic treatments are administered by the department, including outpatient PUVA light treatments, UVB light treatments, Ingram Regime treatments and Goeckerman Regime treatments.

3.5.9 TecKnowledge Healthcare Systems

TecKnowledge Healthcare Systems is a Canadian company which specializing in telemedicine applications. TecKnowledge works with clinical specialists to develop technology-based solutions to clinical "problems" by matching the most appropriate and cost effective technology to the application. By focusing on the clinical and operational requirements of the system, TecKnowledge helps healthcare providers establish effective operational telemedicine programs. They then design custom technology solutions to match with the program requirements.

TecKnowledge has established several major telemedicine projects pioneering telemedicine systems in a variety of different applications including:

- In Northern Ontario, a telemedicine system to link remote nursing stations by satellite to physicians in Sioux Lookout.
- In the Maritime provinces, the Children's Telehealth Network links the IWK Grace Health Centre in Halifax with clinical partners in Saint John, New Brunswick, Sydney, Nova Scotia and Charlottetown, Prince Edward Island.
- A point-to-point teleradiology system connecting the island of Grand Manan with the Atlantic Health Science Corporation in Saint John, New Brunswick.
- In Ontario, a telemedicine system to link the Orillia Soldiers Memorial Hospital with the Hospital for Sick Children in Toronto.
- A telemedicine system to link selected healthcare facilities in the United Arab Emeritus with the New England Medical Centre in Boston, Massachusetts.

TecKnowledge also has assisted the Dalhousie University Faculty of Medicine, the Women's College Hospital in Toronto, Ontario, the Northwest Territories and the Yukon in developing a basis for future telemedicine programs.

3.5.10 MT&T

MT&T (Maritime Telegraph and Telephone Company Limited) is an investor-owned telecommunications company which has served the telecommunications needs of Nova Scotians since 1910. Today, MT&T provides telecommunications consulting and technology solutions and services, including wired and wireless voice, data, internet access and broadcast communications. In 1996, the company had revenues of $595 million and gross telecommunications property of approximately $2 billion.

4. System Description

4.1 Overview

This section describes the technologies and telecommunications used in this pilot project. The basic technical assumption to be tested in this pilot project is whether a multipurpose telemedicine unit can provide a variety of educational and clinical services to a rural area.

The discussion begins with an explanation of the technical architecture, followed by a brief description of the technical design of each site. The final section briefly describes the functional application design.

4.2 Technical Architecture

The telemedicine technology provider, TecKnowledge Healthcare Systems, designed each site's system to their specific operational and clinical requirements. The overall technical approach was to identify the most applicable, lowest cost system hardware and software components to meet the clinical requirements. This focus was necessary as the goal was to determine the applicability of this technology in a more broadly-based system.

TecKnowledge ensured that all systems used standards-based, non-proprietary products so that further refinement of the systems would be relatively inexpensive and additional expansion or enhancements to the system could be easily integrated into the units as required. The overall system design was modular, with the appropriate components selected and installed for each application.

During this pilot project, TecKnowledge further developed and refined the product to better meet the specific needs of the clinical decision makers and the users.

4.3 Technical Design

The design for each site is based on the specific application requirements of that site and a rationalization of possible technical solutions for the different programs (CME, radiology and dermatology). This was done by matching videoconferencing, computer technologies and telecommunications to create a flexible and multipurpose system.

For CME the base technology required at all sites was standard videoconferencing and, as a result, videoconferencing capabilities were included in each site. Those sites participating in the clinical trials required additional capabilities and technologies. The overall design for each of the sites is described in the following sections.

4.3.1 Dalhousie University School of Medicine (Halifax)

This site was used to broadcast CME sessions and used an existing videoconferencing room permanently established at the Dalhousie Medical School. Videoconferencing was conducted using a PictureTel 4000 system with dual 27" monitors, a remote control camera , speakers and microphones. It was fully configured for broadcasting education and training sessions and was equipped with a document camera, 35mm slide projector, a VCR and an interface to a computer to run presentation materials from software applications. A light box was also available for transmitting images of x-rays. Telecommunications are provided through three ISDN lines bonded together by an Ascend MultibandPlus IMUX.

4.3.2 Queen Elizabeth II Health Science Centre (Halifax)

This site was the primary consulting site for both radiology and dermatology. The clinical requirements are:

- *Radiology* - a store-and-forward application in which digitized x-rays were received from the referring sites and were displayed on a greyscale monitor. This site was also equipped with an x-ray digitizer so that the technology and image assessment could be conducted by the radiologists and medical physicists.

  A secondary radiology application was provided for immediate emergency support. This was a videoconferencing application where the radiologist and rural site could videoconference to immediately discuss a case.

- *Dermatology* - a videoconferencing application in which the dermatologist conducted a consultation with a patient at a rural site. Affected areas on the patient's body could be viewed in real-time, and the dermatologist could also request digital snapshots. Snapshots were taken at the rural site using high resolution camera, and the digital files were transferred to the consulting site on the videoconferencing data channel. At the consulting site the dermatologist could view each of the snapshots before making a diagnosis.

With two specialist applications at this site, two workstations were required.

1) The telemedicine workstation was a 486DX4-100 PC with 16M of RAM, a 1.1 Gbyte harddrive and a 17" colour monitor. The operating system was Windows 3.11. Videoconferencing was provided by the PictureTel LIVE100 codec, with a speakerphone and a Canon VC-C1 remote control camera. Telecommunications were provided through two ISDN lines bonded together by an Adtran ISU512 IMUX. To accommodate the quality assurance and image testing, a Vidar VXR-12 12-bit x-ray digitizer was integrated into the workstation so that x-rays could be digitized and assessed.

2) The teleradiology reading station was a 486DX4-100 PC with 32M of RAM, a 1.1 Gbyte harddrive and 1.6k x 2.5k greyscale monitor. The operating system was WindowsNT. Communications were provided through a 56 Kbtye data network with Sheet Harbour and Guysborough.

At the QEII site, the telemedicine workstation and the teleradiology reading station were networked together into a standalone network (via Ethernet).

4.3.3 Cape Breton Regional Hospital (Sydney)

This site was used for receiving CME sessions. It was also fully configured to broadcast CME sessions and was equipped with a document camera. Videoconferencing was conducted on a PictureTel 4000 system with dual 27" monitors, a remote control camera, speakers and microphones. Telecommunications were provided through four data lines bonded together by an Ascend MultibandPlus IMUX.

4.3.4 Northside General Hospital (North Sydney)

This site was a CME receiving site and a referring site for dermatology. The requirements are described below:

- *CME* - a videoconferencing application where the rural site participated in a session broadcast from Dalhousie School of Medicine.
- *Dermatology* - a videoconferencing application where the rural site conducted a dermatology clinic with the dermatologist at the QEII specialist site. The dermatologist viewed affected images in real time or requested digital snapshots of the patient's affected areas. Digital snapshots were taken at the rural site using a high resolution camera, and the digital files were transferred to the consulting site on the videoconferencing data channel.

The telemedicine workstation was a 486DX4-100 PC with 16M of RAM, a 1.1 Gbyte harddrive and a 17" colour monitor. The operating system was Windows 3.11. Videoconferencing was provided by the PictureTel LIVE100 codec, with a speakerphone and a Canon VC-C1 remote control camera. The high resolution camera was a Canon RE650 document camera. Telecommunications were provided through two data lines converted to ISDN by a protocol converter. (Although the system was designed to accommodate four data lines converted to ISDN and bonded together with an Ascend VSX BRI, some of the communications equipment did not arrive on time to test this configuration.) This system was installed on a rolling cart so that the system could move between the patient consult room on the 1st floor and the seminar room on the 5th floor.

4.3.5 Guysborough Memorial Hospital (Guysborough) and Eastern Shore Memorial Hospital (Sheet Harbour)

These sites were CME receiving sites and referring sites for both radiology and dermatology. The requirements are described below:

- *CME* - a videoconferencing application where the rural site participated in a session broadcast from Dalhousie School of Medicine.
- *Radiology* - a store-and-forward application where x-rays were digitized and forwarded to the specialist consulting site for reading. The videoconferencing capabilities were used to provided some emergency support.
- *Dermatology* - a videoconferencing application where the rural site conducted a dermatology clinic with the dermatologist at the QEII specialist site. The dermatologist viewed affected images in real time or requested digital snapshots of

the patient's affected areas. Digital snapshots were taken at the rural site using a high resolution camera, and the digital files were transferred to the consulting site on the videoconferencing data channel.

The telemedicine workstations were 486DX4-100 PC with 16M of RAM, a 1.1 Gbyte harddrive and a 17" colour monitors. The operating systems were Windows 3.11. Videoconferencing was provided by the PictureTel LIVE100 codec, with a speakerphone and a Canon VC-C1 remote control camera. The high resolution camera was a Canon RE650 document camera. Telecommunications were provided through two data lines converted to ISDN by a protocol converter. (Although the system was designed to accommodate four data lines converted to ISDN and bonded together with an Ascend VSX BRI, some of the communications equipment did not arrive on time to test this configuration.) The systems were installed on a rolling carts so that it could be moved between the x-ray room and the seminar room. (Note: Patient consults were conducted in the x-ray room in Guysborough, and the seminar room in Sheet Harbour.)

The Vidar VXR-12 x-ray digitizer remained in the x-ray area. It was attached to the telemedicine workstation through a SCSI cable. This digitizer ran under a software application installed on the telemedicine workstation. Network communications were provided through a 56 Kbtye data network to the reading station in Halifax.

4.4 Application Design

4.4.1 Videoconferencing

Any of the sites could initiate a videoconference call. At Dalhousie and the Cape Breton Regional, making a call consisted of dialing the numbers from the remote keypad. At the other sites, making a call required double clicking on the videoconferencing application icon on the monitor, and selecting a phone number from a "phone book".

All of the videoconferencing systems were configured with multiple, selectable video and audio inputs - allowing users at either end to select which video input they wanted. In the course of a typical consult, the referring staff could first talk directly to the consulting specialist, then change the video input to show a static image or other video image. The specialist could then control the video camera at the patient site to provide views of the patient or other images, and to direct rural staff to achieve optimal consultation results. In this manner, both sides could interact with each other and the images.

The remote control videoconferencing cameras (Canon VC-C1) supported a number of pan, tilt and zoom capabilities. The high resolution cameras (Canon RE650) provided the capability of capturing and transmitting higher quality images to the specialist site. This included transmitting dermatology images, or other pictures.

Additional medical devices or appliances could be integrated into the system if future need arises (i.e. stethoscopes, otoscopes, EKG machines, etc.).

4.4.2 Teleradiology

At the referring (or rural) sites the x-rays were digitized in the normal course of the x-ray technician's daily activity. The digitized images were immediately sent via the network to the reading station at the QEII. The patient requisitions were faxed to the QEII.

The radiologist would take the patient requisition from the fax machine, and locate the patient files on the reading station. He would then open the images, perform the read and dictate his report. This dictation would be typed by a stenographer, and returned to the radiologist for review. Once approved, the report would be faxed to the referring institution and the referring physician, if requested.

4.4.3 Teledermatology

The referring physician would send a patient consult in the same manner as if sending a traditional specialist consult. During the actual consult, the patient and specialist would communicate using the videoconferencing capabilities of the system. Usually, the dermatologist requested a number of digital snapshots of the affected areas. These were transferred to the consultant site for further assessment. The dermatologist would then complete the diagnosis, give advice to the patient (and the referring physician, where applicable), and complete the reporting for the case. A letter was prepared for the referring physician on the results - as would have occurred in a traditional consult.

5. Continuing Medical Education

5.1 Overview

The overall purpose of the CME component of the pilot project was to determine the effectiveness and acceptability of interactive videoconferencing as a medium for providing continuing medical education to rural Nova Scotia communities. The pilot project linked Dalhousie University with two small rural communities (Guysborough and Sheet Harbour), a larger rural community (North Sydney) and an urban community (Sydney) for the provision of continuing medical education. The CME pilot extended from January to June, 1996.

This section describes the CME component of the pilot project. In the following sections background information is given on using this type of technology to deliver CME, the goals of this portion of the pilot project are identified, the program design process is described, and the evaluation process and results are given. This section concludes with recommendations. More detailed technical information on the system used for the CME pilot can be found in Sections 3 and 7, and the cost analysis can be found in Section 9.

5.2 Background

5.2.1 Literature Review

Rationale for the CME project initially arose from the unique needs of rural physicians in Nova Scotia. Like many parts of Canada, Nova Scotia's population is scattered over a relatively large area served by one major academic and referral center. Physicians practicing in rural areas experience working conditions, practice demands and practice content which differ from those working in urban areas. (O'Reilly, 1994; Rourke, 1994). Rural physicians and physicians who are remote from major academic centers also face barriers to accessing continuing education which is pertinent to their practice. These include, most notably, practice responsibilities, travel distance, and cost.

A review of the literature provides only a few studies of the effectiveness of videoconferencing as a delivery system for CME (Gruppen et al, 1996; Hampton et al, 1994). Gruppen, Hutchinson, Gordon and Roser (1996) conducted a study of the effectiveness of providing two two-and-a-half-hour CME programs by interactive videoconference to two groups of surgeons and residents in Canada and the United States (n=506, 703, respectively). They reported that participants' immediate and long-term knowledge increased, performance improved, and level of confidence in managing subject conditions improved. Hampton, Masmanian, and Smith (1994) studied the impact of a one-hour videoconference on breast cancer on 22 physicians and 33 nurses in Virginia They reported a 21% knowledge gain immediately following the videoconference program.

Jennett, Hall, Morin and Watanabe (1995) evaluated the effectiveness of a distance consulting service based on interactive video and integrated computerized technology between Calgary and Drumheller, Alberta. Although physician education was not the primary purpose of the service, physicians and other healthcare providers using the system reported that the service provided many educational opportunities. Consultants also reported that it provided valuable insights into the problems of rural practice.

McDowell, et al (1987) evaluated the provision of CME programs to rural physicians in Alberta using audio-videoconferencing, over a five year period. Their evaluation conclusions included: providing CME by videoconferencing overcame problems of attendance created by distance and cost; participants reported satisfaction with the program content and the technology; handouts circulated prior to the sessions increased the value of the sessions; many participants reported examples of changes made in their practices as the result of the CME programs.

Latchem and Ripley (1992) conducted a study of the effectiveness of continuing education programs provided by videoconferencing to rural nurses in Australia. The goals of the study were to determine the usefulness of the technology for continuing education programs; the participants' levels of satisfaction with the physical presentation, instructional presentation and interactive communication; and the perceived usefulness of the medium for teaching and compared to face-to-face presentations. The evaluation results indicated that the nurses were satisfied with the technology and the program content, the medium was acceptable for providing professional education, and that this method of rural teaching has considerable value and potential.

5.2.2 Nova Scotia Environment

A large portion of Continuing Medical Education is delivered through Dalhousie CME - either through on-site activities (at the university or in metro hospitals), or by sending the expertise to centers remote from the metro area. In the past, this has normally meant that the "expert" had to physically travel to the rural site to deliver the session(s). Recently, Dalhousie CME has been testing the delivery of programs through videoconferencing between Halifax and a rural center - with a great deal of success. Dalhousie CME would like to establish an ongoing capability to deliver CME to rural sites, and to modify their traditional training styles to take advantage of the capabilities of the technology.

Continuing medical education is also coordinated and delivered by regional centers. Although many of these programs may involve bringing in an expert from outside the region, there is also a focus on developing and delivering programs to meet regional needs, using regional expertise. It is becoming less possible for rural physicians to attend CME activities at either a regional or provincial level - due to limited availability of time for travel, and coverage and financial considerations at their location. The regional providers of CME would like to find a mechanism to deliver CME activities to those clinicians in rural areas.

5.3 Goals

The overall purpose of the pilot project was to determine the effectiveness and acceptability of interactive videoconferencing as a medium for providing continuing medical education to rural Nova Scotia communities. The specific goals of the project were:

1) To determine acceptability of videoconferencing as a medium for providing CME by:
    - ⇒ assessing the technical quality of the educational programs (audio, video, etc.);
    - ⇒ assessing the ease/comfort of the instructor and participants using the system;
    - ⇒ identifying the actions of instructors and participants which facilitate and interfere with successful use of videoconferencing technology;
    - ⇒ comparing videoconferencing programs with face-to-face programs with regard to general technical acceptability; and
    - ⇒ determining overall satisfaction with videoconferencing.
2) To remove barriers to attendance at CME programs, such as travel, lost practice time, cost by:
    - ⇒ identifying barriers to participation in traditional CME events;
    - ⇒ identifying whether videoconferencing CME removes barriers which have previously prevented participation in CME; and
    - ⇒ determining if participants are more likely to attend CME offered through videoconference, versus the traditional model, and the reasons for the response.
3) To allow for participant physicians to identify their leaning needs and participate in the selection and development of program topics by:
    - ⇒ assessing degree of satisfaction with the needs assessment process; and
    - ⇒ assessing degree of satisfaction with selected program topics.
4) To provide educationally sound CME programs which meet the participants' needs, by answering the following questions:
    - ⇒ Is the content applicable to the practice setting?
    - ⇒ Did the program meet the learning needs of participants?
    - ⇒ Was the session well organized?
    - ⇒ Were handouts, audio-visual aides useful?
    - ⇒ Was the instructor effective?
    - ⇒ Were specific changes made in clinical practice as the result of the CME programs?

5) To provide interactive CME which facilitates discussion between the instructor and the participants, and between participant sites by identifying the
   - ⇒ type of interaction between the host and rural site(s), and between rural sites;
   - ⇒ frequency of interaction;
   - ⇒ perceived value of the interaction in facilitating learning; and
   - ⇒ perceived effect of the interaction in facilitating establishment of professional channels of communication among physicians in rural sites, and between rural physicians and the instructors.

6) To provide distance CME in a cost effective manner by:
   - ⇒ comparing the costs of providing traditional community hospital programs with the cost of videoconferencing; and
   - ⇒ identifying personal cost-savings for participants as compared to traditional CME

5.4 Program Design

The CME program for the pilot project involved using videoconferencing technology to provide twelve individual programs or sessions to physicians in each of the four sites.

1) Sydney, a secondary referral site - 460 km from Halifax.
2) North Sydney with 12 general practitioners - 30 km from Sydney.
3) Sheet Harbour with 4 general practitioners - 120 km from Halifax.
4) Guysborough with 3 general practitioners - 280 km from Halifax.

Physicians in the other communities participated in program planning via audio teleconferences and site visits by CME staff. They identified program topics which would best meet their learning needs and the most convenient times for the programs, discussed their current CME participation patterns and barriers to participation, and described their expectations of the videoconferencing project.

Fourteen faculty members were contacted to provide the CME programs. All participated in a videoconference training session in the studio at the Faculty of Medicine, Dalhousie University.

Programs were scheduled for presentation to two sites at one time. The rationale for broadcasting to only two sites, as opposed to four sites simultaneously, was to facilitate ease of interaction between the instructor and the participants, all of whom have no prior experience with the technology. Each program was therefore presented twice, resulting in a total of 24 videoconference sessions. The pairing of sites and the times of broadcast to each site were varied so that each site has the opportunity to interact with each other site, yet receive the majority of their programs at their preferred times.

5.5 Evaluation Methods

The evaluation was designed to assess the specific project goals and objectives, and was conducted throughout the three program phases. The methods used are described below:

1) Pre-project phase
   - ⇒ Site visits, using case study data collection method.
   - ⇒ Survey of target physician population regarding current CME attendance and barriers to attendance.
2) Project phase
   - ⇒ Instructor and participant evaluations of each session, using brief questionnaires designed for this purpose.
   - ⇒ Mid-project focus group meeting with participants regarding program effectiveness and areas for improvement.
   - ⇒ Attendance.
   - ⇒ Cost of programs as compared to traditional community CME programs.
3) Post-project assessment
   - ⇒ Participant focus groups regarding overall satisfaction and degree to which the project goals were met, recommendations for improvement of the videoconference program, recommendations for the future of videoconferencing in their community and in Nova Scotia.
   - ⇒ Completion of instructors' questionnaire regarding their general impressions of the videoconferencing program, its benefits and disadvantages, and recommendations.
   - ⇒ Questionnaires completed by the education managers who coordinated the logistical components of the program in the two urban sites.

5.6 Pre-project Evaluation Results

5.6.1 Site visits

Visits were made to each of the four sites during the project planning stage. In addition to conducting a CME learning needs assessment, CME staff collected qualitative data on:

- the physicians' (and, in the two rural hospitals, the administrators') expectations of the CME project;
- the current problems and barriers inherent in the physicians' practices which interfere with their participation in CME events;
- the physical location of the videoconferencing equipment within the hospital; and
- the technical training needs of the physicians related to use of the equipment.

This information was used in program planning, and in the development of specific evaluation tools for use in the project and post-project phases.

5.6.2 Physician Questionnaire

Prior to the first program, a one-page "Physician Pre-project Assessment" was mailed with a brief letter describing the project, to each of the identified 180 urban and small town physicians in Sydney and North Sydney, the seven rural physicians in Guysborough and Sheet Harbour, and six rural physicians in Baddeck who had expressed an interest in the program and could travel to nearby North Sydney to participate. The purpose of the pre-project assessment was to identify the amount of time physicians currently spent in CME, and barriers to participation in CME.

Thirty-six responses were received from the "urban" physicians (20.0% response rate) and ten from the 13 "rural" physicians (76.93% response rate). While there are reservations about the sample size and representativeness of the data presented, the findings regarding rural physicians are consistent with those presented in the literature.

Although "practice responsibilities" was the most frequently perceived barrier to participation by both rural and urban physicians, 90% of rural physicians identified it as such compared with 72% of urban physicians. "Distance to travel" was identified as a barrier by 70% of rural physicians and 64% of urban physicians.

5.7 Project Evaluation Results

5.7.1 Participation

Although the CME program was designed for physicians, the sessions were open to other healthcare professionals. All participants, physician and non-physician, were asked to complete an evaluation questionnaire for each session attended.

Attendance by physicians at individual CME programs ranged from two to sixteen. It should be noted that a higher percentage of rural community physicians, the primary target audience, attended the series of programs than urban physicians. Of the 332 sum total of participants, 269 were physicians. A total of 230 individual program evaluations were received, of which 195 (81%) were physicians and 35 (19%) were other healthcare professionals, predominantly nurses.

5.7.2 Participant Evaluation of Individual Programs

Participants were asked to evaluate each session with regard to the quality and effectiveness of two domains - session content and presentation, and videoconference technology. This was done using a five-point Likert scale to rate degree of agreement with descriptive statements pertinent to each domain. Participants were also asked open-ended questions on suggestions for improvement and overall evaluation of the session.

Over 87% of physician participants agree to strongly agree with the positive statements describing program content, presentation and organization, except for the last statement referring to handouts, for which the percentage is 81.7%.

Responses to the open-ended questions are summarized as follows:

1) The content is valuable, and applicable to practice.
2) Sufficient opportunity for interaction is generally provided. Participants are generally pleased with the case-based interactive teaching methods which the majority of instructors are utilizing. Several participants described finding the interaction uncomfortable at first. One participant consistently prefers more didactic teaching methods.
3) Handouts (distributed to the sites prior to the program) are a valuable contribution to the program. The format of these has varied, and have consisted of overviews of the program, reference materials, and/or guidelines for clinical management in an office practice.
4) Participants have requested (and received) additional reference materials from the faculty, and requested additional programs, one of which could be provided within the constraints of this pilot project. (These comments were received verbally during specific sessions, as well as being recorded on the session evaluation forms.)
5) Participants like the use of the document camera by instructors for demonstrating specific instruments and/or procedures; e.g., use of new endotracheal tubes and nebulizers; techniques for difficult deliveries.

About 90% of physician participants agreed or strongly agreed that the quality of sound was satisfactory, and 83% agreed or strongly agreed that the videoconference equipment allows for effective interaction. However, only 64.9% agreed/strongly agreed that the picture quality was satisfactory, and 13.1% disagreed/strongly disagreed with this statement. Primarily, this is because the system operated with the bandwidth of a single ISDN line connecting sites as opposed to the two originally planned, which reduced picture clarity. The use of audio-visual aids elicited the broadest range of responses, with 11.6% indicating that they disagreed or strongly disagreed with the statement that the equipment enabled effective use of audio-visual aids. Overall, 71% indicated that videoconferencing worked as well as face-to-face presentations.

Specific problems which were identified in response to the open-ended questions include:

1) Poor picture quality.
2) Sound quality is better than the picture quality, but the audio lag between sites which results from having only a single ISDN line interferes with ease of interaction, and is perceived as a barrier to effective communication, especially early in the pilot.
3) Clear transmission of audio-visual aids; i.e., 35 mm slides and Power Point slides, has been problematic. (This was identified in the first three months of the project, and subsequently specific changes were made to the development and transmission

of audio-visual aids, with some improvement noted.)

4) Other technical problems have interfered with program transmission. These resulted in one or two sites not being able to receive one or two particular programs, one site only being able to hear but not see, the screen "freezing" in one site. These and other technical problems were quickly addressed by the TecKnowledge.

In summary, participants appeared to value the CME programming being received.

5.7.3 Comparison of Physician and Non-Physician Participant Responses

Nineteen percent of the evaluation questionnaires received were from non-physician participants, primarily nurses. Their quantitative responses were evaluated in comparison with those of the physician participants.

The mean ratings of degree of agreement/disagreement with the descriptive statements by physicians as compared to non-physicians are very similar. The non-physician group almost consistently indicated a minimally higher degree of agreement with each statement, and the standard deviations of the responses of non-physician group were almost consistently lower.

5.7.4 Faculty Instructor Evaluation of Individual Programs

Faculty were asked to evaluate the quality and effectiveness of two domains, instructor training and support provided and the videoconference technology, using a five-point Likert scale to rate degree of agreement with descriptive statements pertinent to each domain. They were also asked open-ended questions regarding suggestions for improvement and overall evaluation of the session.

Thirteen of the fourteen program faculty completed the evaluation questionnaires for their sessions, for a total of 24 completed evaluations. Over 95% of faculty agreed or strongly agreed with positive statements concerning training and support provided. However, there was markedly lower agreement with some statements concerning the technological components: 58.3% agreed to strongly agreed that the picture quality was satisfactory; 70.8% , that the sound quality was satisfactory; 75%, that the equipment allowed for effective interaction; 62.4%, that the videoconference equipment did not interfere with the presentation; 58.3%, that the videoconference format works as well as face-to-face presentations.

These ratings are generally lower than those assigned by physician participants to the technological aspects of the program. One possible explanation for the lower faculty ratings is that the majority of faculty only participated in two sessions (some in only one), which limited their exposure to and opportunity to become comfortable with the system. On the other hand, most participants attended more than two sessions, and some attended all sessions at their location.

Faculty responses to the open-ended questions were similar to some of the physician participant responses. They identified problems which included discomfort with the time lag and the sense that it interfered with effective interaction, and dissatisfaction with the picture quality. However, faculty generally expressed enthusiasm for using the technology to present CME programs to physicians in distant parts of the province. One comment was "This is so much easier to do than travel." Other faculty members indicated that they were exploring using the technology to consult with colleagues in the Maritime provinces.

5.7.5 Mid-Project Focus Group Meeting with the CME Physician Coordinators

A videoconference meeting was held at mid-point in the programming schedule, for the purpose of gaining the general reaction of the coordinators and their colleagues (as reported to them in an informal manner), to the videoconferencing system and the CME programs. The questions asked and responses provided are summarized in the following pages.

1) *Are there any problems with program logistics?*
   - ⇒ Sydney suggested that program notices be sent to nursing units and patient care departments, such as Social Work, Pharmacy, in addition to physicians. Staff from these areas have expressed concern that they feel excluded because they are not informed of the programs.
   - ⇒ The coordinators agreed that participation by other healthcare providers should be encouraged, and that exposing as many healthcare professionals as possible to the educational benefits of videoconferencing should be an additional goal of the pilot project.
2) *General impression of sessions to date; i.e., Is the content appropriate and meeting learning needs? Does the technology seem to be acceptable?*
   - ⇒ Each coordinator reported that those attending the sessions were generally very positive about the program content and about the technology.
   - ⇒ North Sydney reported that they had already implemented some changes in practice in the Emergency Department based upon a CME session.
   - ⇒ One site reported that specialists had requested use of the videoconference system for communication with colleagues in the Maritimes.
   - ⇒ Both rural sites were extremely pleased with the CME programs.
   - ⇒ Problems exist with the technology, particularly as related to picture quality and audio lag, but it is anticipated that these will be corrected with additional communications bandwidth.
3) *Overall, what is best liked about the videoconference CME? What are the benefits?*
   - ⇒ Excellent quality of the programs.
   - ⇒ Accessibility of specialist expertise.
   - ⇒ Access to accredited CME programs.
   - ⇒ No travel time required (especially for rural sites).

- ⇒ Learning from other sites through their interaction with the faculty.

4) *What seems to be liked the least? What are the disadvantages?*

- ⇒ Technological problems such as poor picture quality and the audio time lag which interferes with spontaneous interaction.
- ⇒ The coordinators report that they and their colleagues found using the system unnerving at first. Factors which contributed to this sense are unfamiliarity with the system, and discomfort caused by the audio time lag. A comment: "This is different from traditional CME sessions, where you can sit in the back of a lecture room and remain inconspicuous. With the VC system, we are front and center, especially in the smaller PC-based sites." The degree to which site participants feel more at ease with the system appears to increase with frequency of use, although the audio lag continues to be frustrating.
- ⇒ Scheduling of sessions: The Cape Breton Regional site and Northside General site both found the scheduling of the sessions problematic. Sydney, the largest site, had polled the physicians and found they were fairly equally divided between early morning, noon hour, and evening sessions. North Sydney was finding it difficult to encourage a good turnout, but this improved over the course of the sessions. The consensus is that those who are interested and able will come, and that no one time is "best" for all.
- ⇒ Technological "glitches".

5) *Other suggestions for improvements, general comments.*

- ⇒ Videotaping of sessions would allow those who miss sessions to see them at a later date.
- ⇒ Suggestions were made for more comprehensive CME videoconference programs (three to four hours on a Saturday morning) and for more programs.
- ⇒ Having a trained support person on site who is readily available facilitates use of the program by physicians. The larger sites have this support, although not consistently, whereas the rural sites depend upon the physician coordinator.

5.8 Post-Project Evaluation Results

Outcome evaluations conducted upon completion of the project included:

1) Instructor questionnaires to measure overall satisfaction and recommendations for future use of system.
2) Focus groups with participants in each site to identify overall satisfaction, recommendations for future, impact upon barriers to participating in traditional CME (including cost), changes made in clinical practice as a result of the CME videoconference sessions.
3) Questionnaires for the education managers in the two urban sites, who served as site and logistical coordinators for the program.

5.8.1 Summary of Instructor Questionnaires

Questionnaires were sent to the twelve faculty who participated as instructors in the program, to assess their overall satisfaction with the program and receive their recommendations for future use of system. Nine questionnaires were returned.

The following is a summary of the results:

- All faculty agreed or strongly agreed with the statements, "I would be willing to provide more CME programs by videoconference to community physicians" and "Dalhousie CME should continue to provide programs via videoconference to complement the traditional community hospital program".
- The benefits to faculty of providing CME by videoconference included decreased travel time (5 responses), time saving (3 responses), broader coverage; i.e., can provide CME to more than one community at a time (2 responses).
- The disadvantages for faculty included lack of personal contact with audience (2 responses), less spontaneity from audience (2 responses), lack of informal discussion time (1 response), lack of time to discuss cases privately (1 response), sense of discomfort with equipment (1 response), borderline technology (1 response).
- Eight faculty said that they could foresee using the videoconference system for other uses such as consultation with colleagues in the Maritimes, patient consultation, grand rounds, meetings, etc. The ninth was unsure at this time.
- Faculty were asked for suggestions to improve their preparation for teaching in the videoconference CME program. Two suggestions were made: provide more assistance with slide preparation and provide a longer training period. The others appeared satisfied with their training. Faculty were also asked if a short training video would be of assistance to them in preparation. Three said that it would be.
- Eight of the nine faculty indicated that although there was dissatisfaction with the picture and audio quality, this would not decrease their willingness to participate in future programs.

5.8.2 Summary of Participant Focus Group Evaluations

Focus group evaluations were conducted with program participants in each of the four sites. In Sheet Harbour, the three community physicians, hospital administrator and director of nursing attended. In Guysborough, the three community physicians attended, and the hospital administrator, who is also the director of nursing, was able to make a brief contribution to the meeting. Three physicians attended each meeting in the Sydney and North Sydney sites. The following is a summary of the key points made by the four groups:

1) *What is your overall opinion of the videoconferencing project?*

   ⇒ Unanimous response - the program was very worthwhile, extremely positive, excellent.

2) *What did you like the most?*
   3 of 4 sites:

- Interaction with the instructor - much better than expected (one site said it was better than in face-to-face CME, as they were more inclined to ask questions)
- High quality, pertinent educational programs which met their needs.
- Case presentations.
- Removal of barriers to attend traditional CME, particularly lost time from practice and family, and distance to travel. Easy access.
- Individual program handouts.
- Opportunity for all or most physicians in a location to learn together - impossible for all to attend a CME session outside their community.
- Accredited CME.

2 of 4 sites:

- Rural physicians stressed that the barriers for attending traditional CME severely limit their attendance, and that a program such as this is most valuable, if not necessary, in helping them to keep current. (Physicians in the two other sites reported many additional opportunities for CME, although not for accredited CME.)
- Opportunity for other professionals, especially nurses to attend. Particularly in rural sites, traditional continuing education for nurses and other professionals is expensive for sponsoring institutions.
- Interdisciplinary learning - it is valuable to include nurses and other healthcare professionals in educational programs, especially in small rural hospitals.
- Sessions triggered additional discussions among colleagues following presentations.

3) *What did you like the least?*

- Technical quality - audio lag interferes with communication; picture not always clear; audio visual aides often unclear. However, these are generally not serious problems, participants adjusted to them and improvements in audio-visual aids were made.
- Program schedule - difficult to find a convenient time for all.
- PC monitor screen too small.

4) *Did your perceptions of videoconferencing change as the series progressed? If so, how?*

- Uncomfortable with the technology at first, but became comfortable. Generally became accustomed to reduced picture quality and audio lag. Participation and interaction increased.

5) *Identify any changes in practice you have made as a result of the VC sessions.*

- management of migraines
- corneal abrasions don't need patching
- checking for ankle fractures - saved some x-rays

- ⇒ rotation of shoulder for dystocia
- ⇒ dilantin dosages (loading and adjusting)
- ⇒ emergency management of asthma
- ⇒ use of a new nebulizer in treatment of asthma
- ⇒ management of more minor emergency conditions
- ⇒ prednisone protocol for spinal cord injuries
- ⇒ use of the diagnostic checklist for dementia, by both nurses and physicians

6) *What suggestions would you make for improving the VC programming?*
3 of 4 sites:

- ⇒ The audio and picture problems are not considered serious: i.e., if funds are limited, it would be more important to use them to develop program content as opposed to improving technical quality.
- ⇒ Provide a bigger screen (PC-based sites).
- ⇒ Invite other healthcare professionals, especially nurses, to the programs.

2 of 4 sites:

- ⇒ Continue to improve audio-visual aids.
- ⇒ Schedule more informal discussion time with the instructor at the end of the session.
- ⇒ Schedule a regular time for programs in each site, as opposed to a rotating schedule.
- ⇒ Assist faculty members to increase the amount of interaction in their sessions.

7) Results of this pilot project will be considered in decision making regarding the future usage of *videoconference* technology in healthcare in Nova Scotia. Please make any additional comments, suggestions, and/or recommendations that you feel would be useful to this process.
4 of 4 sites:

- ⇒ Continue the program. All sites value the program; however the videoconference CME removes significant barriers (notably time lost from practice and cost) to attending traditional CME for the rural physicians, and hence they view it as particularly valuable. All sites would like to have a program beginning in the fall.
- ⇒ Expand the program throughout the province. The priority locations would be rural hospitals and 24-hour healthcare clinics. The intent is not to replace traditional CME programs, but to supplement them.
- ⇒ Expand the program to include other health professionals, such as nurses, physiotherapists, pharmacists, etc., as these rural professionals are faced with the same barriers to continuing education as physicians. Including other groups, through their professional associations and/or the Dalhousie Faculty of Health Profession, would also increase financial support for the program.

- ⇒ These sessions were all pertinent to medical practice in the rural sites. Conduct a similar needs assessment with the participating sites prior to planning the next series of programs.

1 or 2 of 4 sites:

- ⇒ Provide a central system for emergency consultations by rural sites to tertiary care hospitals, with a single number.
- ⇒ As there are no plastic surgeons in Sydney, use the system for consultations in plastic surgery.
- ⇒ Use the system for regional meetings; e.g., for administration, nursing and other meetings within the Cape Breton healthcare region.
- ⇒ Consider offering an expanded program on a topic, with several speakers; e.g, on a Saturday morning.
- ⇒ Seek financial support for particular programs from pharmaceutical companies.
- ⇒ Physicians may be willing to pay a subscription fee for a series of CME videoconference programs.
- ⇒ Funding for programs for other professionals could be obtained by diverting hospital education funds which are currently used for travel, accommodation and replacement staff for those who attend traditional continuing education programs.

5.8.3 Summary of Questionnaires of the Education Managers

The education managers in the Cape Breton Regional Hospital and the Northside General hospitals, who were also nurses, served as site and logistical coordinators for the program in their sites. Their responses to the program were requested, and are summarized below:

1) *What is your overall opinion of the videoconferencing project?*
    - ⇒ Excellent mechanism for providing continuing education programs.
    - ⇒ Worthwhile and satisfactory.
2) *What do you consider to be the major benefits of the system?*
    - ⇒ Accessibility - improves access to educational opportunities for all health professionals. Permits the sharing of these valuable resources in a cost-effective manner.
    - ⇒ Elimination of travel.
    - ⇒ User-friendly atmosphere.
3) *What do you consider to be the major disadvantages?*
    - ⇒ None

4) *Please comment upon the logistical and technical support required to make a program like this successful.*

   - ⇒ Minor difficulties with videoconferencing bridge numbers.
   - ⇒ Technical problems resulted in time away from my position responsibilities, which, at times created difficulties for our department. However, the external support received was exceptional and I really could not offer any recommendations for improvement.

5) *What additional suggestions would you make for improving the VC programming?*

   - ⇒ We encountered problems with physician availability for some programs. We would welcome being able to videotape the presentations.

6) *What interest, if any, has been expressed by other healthcare professionals in using the system?*

   - ⇒ Some members of nursing staff attended some sessions. They expressed enthusiasm for and satisfaction with this system. It would also be valuable for other healthcare providers, such as in social work, diagnostic imaging, laboratory.
   - ⇒ Hearing and Speech personnel have expressed an interest. Additional potential users could be Dalhousie nursing distance education programs; i.e, Masters in Nursing program, PEPP program.

7) *Results of this pilot project will be considered in decision making regarding the future usage of videoconference technology in healthcare in Nova Scotia. Please make any additional comments, suggestions, and/or recommendations that you feel would be useful to this process.*

   - ⇒ Videoconference technology provides access to specialized healthcare services, and communication and educational opportunities for health professionals. I would strongly recommend the use of the technology in healthcare in Nova Scotia.

5.9 Conclusions

Conclusions drawn from the evaluation results include:

1) The goals of the project were met.

   - ⇒ The videoconferencing technology is acceptable as a medium for providing CME. Although technical quality was not found to be entirely satisfactory, participants and faculty valued the CME.
   - ⇒ Videoconferencing CME removes barriers such as travel, practice responsibilities, coverage issues and costs, particularly for the rural physicians. Faculty instructors also reported a preference for using videoconference to deliver CME to more distant communities.
   - ⇒ Participant physicians reported satisfaction with the opportunity to identify their learning needs and to participate in the selection program topics and were satisfied with the resulting program content.

- ⇒ Participant physicians reported that the programs were educationally sound with regard to content, presentation and organization and met their needs. They also reported examples of changes made in clinical practice as the result of individual programs.
- ⇒ Interactive CME was provided which facilitated discussion between the instructor and the participants. This was identified by physician participants as one of the major program strengths. Participation between sites did not occur and was not perceived to be important by the participants.
- ⇒ Community CME can be provided in a more cost effective manner as compared to the traditional Dalhousie community "visiting professor" program. It is also more cost effective for participants who must travel for CME activities.

2) Receiving CME by videoconference was found to be valuable by all participants, but was perceived to be particularly valuable for rural physicians who practice in more isolation and are more restricted in their ability to attend traditional CME.

3) Although the program was designed as a continuing medical education program directed toward physicians, 19% of participants completing evaluation questionnaires were non-physicians, primarily nurses. Videoconferencing was considered to be a worthwhile means for providing continuing education to other health professionals. Additional advantages of attendance by other healthcare disciplines were interdisciplinary learning and team building.

5.10 Recommendations

The videoconferencing CME was perceived to be valuable by both rural and urban participants, and by faculty. They also believe that the system has significant potential for healthcare practitioners in Nova Scotia.

Based upon the success of this pilot project, the following recommendations for the future use of interactive videoconferencing in continuing education for health professionals in Nova Scotia are made:

1) Expand the continuing education program to include other healthcare professionals and more rural sites in Nova Scotia.

2) Identify other communication needs of health professionals which could be met by interactive videoconferencing; e.g., consultation with colleagues, meetings of regional healthcare managers, professional meetings, etc.

3) Seek funding support from various sources; e.g., professional societies, individual hospital education budgets, physicians themselves.

4) Continue to identify learning needs with participant physicians in planning new programs, and continue faculty development in videoconferencing for those faculty teaching in the program.

6. Radiology Specialist and Support Services

6.1 Overview

This section describes the teleradiology pilot. The overall purpose of this component of the pilot project was to determine the effectiveness and acceptability of digitizing x-ray films and transmitting them for diagnosis. The teleradiology component of the project linked the Radiology Department of the QEII Hospital with two rural communities, Guysborough and Sheet Harbour, for the provision of distance radiology services. The teleradiology pilot project extended from September to December, 1996.

In the following sections background information is given on using on teleradiology, the goals of this portion of the pilot project are identified, the teleradiology process is described, and the evaluation process and results are detailed. This section concludes with recommendations. Technical information on the system used for the teleradiology pilot is described in Section 4. The results of the extensive technical assessment are reported in Section 7, and the cost analysis and summary is can be found in Section 9.

6.2 Literature review

Teleradiology is the one area of telemedicine for which standards have been developed for the technical quality of the service (Tangalos, 1995; ACR Standard for Teleradiology, 1994; Standards for teleradiology of the Canadian Association of Radiologists, 1995).

Several publications report on the benefits of teleradiology. Rinde et al (1993) report that teleradiology services in Norway are replacing rural clinics. Preliminary studies show that teleradiology is a viable solution for areas without radiologists or as support for radiologists practising in isolation. Their studies also show that teleradiology results in "little loss in picture quality and gains in the quality of care" (p.75,76). Barnes et al (1993) reviewed several American teleradiology programs and conclude that teleradiology can assist the practice of radiology in several ways. These include improving communication between radiologists and referring physicians, improving the ability to deliver timely radiologic care in rural settings, and increasing the efficiency of radiologic services.

Felix et al (1993) provide a summary of the state of teleradiology in 1993 in the Berlin area presenting an experience of 4 years' duration. Dohrman (1991) reports on an Australian teleradiology service utilized in a neurosurgical department for both emergency and routine needs. He concludes that it has proven to be a simple, effective and low-cost way to transmit valuable clinical data and to improve the quality of clinical communication. He predicts that teleradiology has the potential to transform the early management of critically ill patients, especially those in rural areas of the country. Hassol (1996) briefly summarizes findings from the American rural telemedicine survey with regard to teleradiology. Of the 558 institutions involved in telemedicine projects, 68% (340) were utilizing teleradiology.

Swartz (1996) explains factors associated with the transmission of analog information in digital format. Various studies have been conducted to determine the technical quality and diagnostic accuracy of teleradiology. Brown (1996) provides an annotated list of these and other teleradiology studies, some of which report that the diagnostic performance of digitized images and teleradiology systems is equivalent to that of analog systems, and others reporting that it is inferior. Halvorsen and Kristiansen (1996) also provide a fairly comprehensive bibliography of various studies of the quality and accuracy of teleradiology, some support the use of the technology and others do not.

Scott et al (1993) conducted a study of subtle orthopaedic fractures using 60 films showing subtle abnormalities and 60 normal films with multiple readers. Results demonstrated an accuracy of film interpretation of 80.6% for plain films and 59.6% for screen readings. Sensitivity was 78.5% for film and 48.8% for screen images. The reading monitors were limited to 1280 x 1024 pixels. The conclusion was that the system was not acceptable for primary diagnostic interpretation of difficult fracture cases.

Goldberg et al (1993) conducted a prospective study of diagnostic accuracy in 685 transmitted clinical cases. This was a comparison of video and plain film interpretation of radiology exams which showed discrepant interpretation in 18 cases (2.6%); sensitivity 96%, specificity 99%. An arbitration committee concluded that most discrepancies were due to observer performance.

Wilson and Hodge (1995) conducted a performance comparison between digital radiographs and the original film images in skeletal trauma. The review consisted of double interpretations of 180 films, 48 with 66 subtle fractures, 100 with 156 nonsubtle fractures and 40 with no fractures. They noted a loss of accuracy in reporting of digital images and conclude that this is probably related to unfamiliarity with the viewing station pointing out the learning curve associated with digital radiology interpretation.

Two studies report upon efforts to measure the costs of teleradiology. Halvorsen and Kristiansen (1996) conducted a study in Norway to determine the social costs of providing a rural population with radiology services under three different systems - the existing system (a small x-ray unit at the rural site and all other examinations at the host site), a teleradiology system, and a system whereby all examinations were conducted at the host site. Costs of teleradiology were divided into three categories which included direct medical costs, direct non-medical costs such as patient travel, and indirect costs to the patient which were identified as "production" losses. Production losses were defined as a loss of productive time for those patients who were employed, and a loss of leisure time for those who were not employed. Results indicated that the existing system was the least costly option except when patient lost leisure is valued as highly as lost production, in which case teleradiology would be the least costly. This is a valuable study as detailed descriptions of methodology and discussions of variables considered in the assessment of costs are included.

Hilsenrath et al conducted a study to determine the indirect patient costs for teleradiology in rural Nebraska. They defined indirect patient costs as transportation costs and the opportunity costs of time. They conclude that teleradiology can avert some patient costs. These may be significant in low income areas, where they suggest that the use of teleradiology may help to sustain both the hospital and the local economy.

In summary, teleradiology is deemed to be of value to patients and physicians, especially those located in rural areas. As new systems are introduced, technical studies are required on an individual basis to determine their diagnostic accuracy. More objective studies of the impact of teleradiology on the delivery of patient care and particularly, on the costs of care, are also required.

6.3 Goals

The purpose of the pilot project in teleradiology was to improve support to the physicians in Sheet Harbour and Guysborough through the provision of rapid and accurate film interpretation. The goals of the pilot project were to determine:

1) Technical quality and accuracy of the teleradiology service by:
    - ⇒ assessing radiological quality and consistency of radiographs produced at each sending site, hardware and software performance at send and receive sites, and integrity of the transmitted images; and
    - ⇒ determining the diagnostic accuracy of the system by "double-reading" the digitized films.
2) Acceptability to those participating in the teleradiology service, including referring physicians, rural site technologists, rural site administrators, consulting radiologist by:
    - ⇒ identifying referring physician acceptability by assessing speed and efficiency of receiving reports, reliability of the system, communication with consultant;
    - ⇒ identifying rural site x-ray technologist acceptability by assessing ease of use and support processes for teleradiology (e.g. transfer of patient documents, storage for films, reliability of the system, technical training and support, communication with consulting radiologist, staff at consulting site); and
    - ⇒ identifying consulting radiologist acceptability by assessing ease of use and support processes for teleradiology (e.g., transfers of patient documents, film storage, technical training and support, communication with staff at the rural site, reliability of the system)
3) Impact upon quality of patient care and healthcare outcomes by:
    - ⇒ identifying instances in which the use of teleradiology had an impact upon the quality of care, patient health status and/or health outcomes, as compared to the traditional radiology service.

4) Impact upon access to healthcare by:
   - ⇒ determining the availability and speed of teleradiology services as compared to traditional system; and
   - ⇒ identifying the impact on use of radiology services (i.e. Did the number of examinations ordered change due to availability of the service?)

5) Impact upon existing institutional operating and support processes by:
   - ⇒ identifying institutional factors which had an impact upon the smooth organization and implementation of the service; and
   - ⇒ identifying unforeseen barriers to the efficient running of the process.

6) Impact of teleradiology upon the cost of healthcare for the rural and consulting institutions, the public, patients by:
   - ⇒ identifying the costs associated with providing teleradiology services and compare them to those of traditional consultations: for the rural site: technologist's time, cost of transporting films, reports, for the consulting site: consultant's time, support services, for the public: above, plus financial savings due to decreased number, of emergency ambulance transports, for the patient: personal savings due to earlier diagnosis; and
   - ⇒ identifying teleradiology capital and maintenance costs.

7) Real/Potential effects upon the delivery of healthcare in Nova Scotia by:
   - ⇒ identifying how patterns or systems of care changed or could be changed by the adoption of teleradiology; and
   - ⇒ identifying benefits for rural physicians.

6.4 Radiology Processes

6.4.1 Traditional process

Guysborough hospital does not have on-site radiology services and films are forwarded daily by bus to St. Martha's Hospital in Antigonish - a trip of just under one hour. Sheet Harbour also does not have on-site radiology services except for fluoroscopy examinations provided one day every two weeks by a radiologist from the Dartmouth General Hospital. Flat films are sent daily to the Dartmouth General by bus and by courier, a trip of about two hours.

The technologist in each institution is responsible for packaging the previous days' films and any films taken in the early morning for transport by bus at 9:30 a.m. At both sites, films taken after 9:30 a.m. are not be sent for interpretation until the next morning. Packaging involves placing the films in individual patient envelopes and putting the envelopes in a larger container. In the receiving institutions, the interpretations are usually completed on the day received. Guysborough generally receives films and reports by return bus late the following day for a turnaround time of approximately 48 hours. Sheet Harbour either receives their films and reports by return bus the same evening or the next evening. Reports are received on tape, and are transcribed by medical records staff at Sheet Harbour.

More urgent cases are responded to by phone upon notifying the radiologist at the receiving hospital. This could mean a delay in receiving the report of up to 24 hours, or for a longer period if the patient were admitted on the weekend. If the situation were an emergency, the patient could require ambulance transport to St. Martha's or the Dartmouth General, respectively, or to a tertiary care hospital in Halifax, depending upon the patient's condition.

6.4.2 Teleradiology process

The procedure for teleradiology was identical in both referring sites. Films were taken in the usual manner and, following development, were passed through the film digitizer and transmitted to the receiving site. The scanning time for an average film was approximately 10 seconds. The transmission time to the reading site was approximately 5 minutes for a standard chest film or 10 minutes in total for a two-view chest examination. The technician was required to be present during the scanning but not during the transmission of the films. The films would then be placed in envelopes and filed in the usual fashion. The x-ray requisitions were sent by standard fax.

At the consulting site the presence of the requisition on the fax machine cued the radiologist that a film either had been sent or was in the process of being sent. Occasionally a film was received before the requisition, and the radiologist would wait receipt of the requisition before proceeding. Using the information on the requisition, the patient was entered into the Queen Elizabeth II Radiology Department patient record system, and the requisition was then returned to the viewing site. The film was viewed at the computer reading station and reported in the standard manner, usually within 12 hours of receiving the film and the requisition. After sign-off by the radiologist, the report was transmitted by fax modem to the referral site. As the project progressed, a clerical support person was assigned to manage patient documentation and to serve as the communications link with the rural sites.

Upon receipt of the reports at the referral sites, the technologists' made additional copies of the report for the physicians and medical records office.

For films requiring reading outside regular working hours both referring institutions were given the phone number of the emergency x-ray department. The radiology residents and most of the department radiology staff were instructed in the basics of using the equipment.

6.5 Evaluation Methods

Evaluation methods included:

1) Initial technical quality evaluation of the teleradiology project prior to project initiation:

⇒ *Quality assessment:* A technical assistant visited both sending sites to assess the image quality of their radiographs. If necessary, recommendations were made to achieve better radiographs.

⇒ *Software performance:* The performance of the software was evaluated for (a) the steps it took to locate the received images, (b) the steps necessary to view an image, (c) the image manipulation steps required to properly assess an image, and (d) the ability and required steps to view multiple images of the same patient.

⇒ *Hardware performance:* Evaluation of the hardware involved assessment of the x-ray scanner, the computer hardware and the display monitor. The x-ray scanner was evaluated for adequate translation tables for different types of examinations, film slippage, optical density conversion and distance linearity. The computer hardware was evaluated for speed to perform assigned tasks, image storage capability and overall system integrity. The display monitor was assessed for image brightness, distance linearity and image contrast.

⇒ *Integrity of transmitted images:* Integrity of the transmitted images is a compromise between image scanning parameters, transmission speed (and cost) and the ability of the hardware to handle image manipulation processes within a reasonable time. The image quality (of both actual patient images and patient-simulating phantom images) were assessed for visibility of known pathology and specific image features.

2) Overview of radiographic examinations conducted (number, type).

3) "Double-read" of original films at the rural site upon completion of the project.

4) Rural site focus group evaluation meetings and individual interviews with referring physicians, radiology technologists, hospital administrators, and the consulting radiologist.

5) Review of costs.

6.6 Evaluation Results

6.6.1 Technical Quality

The technical assessment results are given in Section 7.

6.6.2 Overview of Radiographic Examinations Conducted

Teleradiology services were established with the Guysborough hospital from the beginning of September through to the end of December, 1996. Teleradiology services were not initiated with the Sheet Harbour hospital until the beginning of November and ended in mid-December, 1996.

A total of 808 examinations were carried out, 548 from the hospital in Guysborough and 260 from the Sheet Harbour hospital. Examination types were chiefly chest and bone films with a small proportion of abdominal examinations, including one intravenous pyelogram. The greater proportion of the radiographs from Sheet Harbour were bone examinations; the greater proportion from Guysborough were chest examinations. Four urgent or emergency examinations were conducted with Guysborough.

6.6.3 "Double-read" of Original Films.

To determine the diagnostic accuracy of the teleradiology system, a proportion of the original films (as opposed to the digitized films) were read and the reports were compared with those for the digitized images originally read during the pilot study. The purpose of the "double-read" process was to determine the degree to which image detail was lost in the digitization, transmission image re-creation processes.

The first stage of the "double-reads" of the original films was completed by the consulting radiologist who read the majority of the digitized films during the pilot. Assistance in determining the sample size and extrapolating the results from such a sample to the general population was provided by a biostatistician with the Department of Community Health and Epidemiology, Dalhousie University. The sample population in Sheet Harbour was selected from the entire six-week test period. For Guysborough, the sample was selected from examinations conducted in October, November and the first two weeks in December.

The consulting radiologist read the original films in each of the rural sites upon completion of the pilot project. He was blinded as to the earlier diagnosis made at the QEII from the digitized films. He had available the same patient information as he had at the QEII (the original patient requisition). After reading each film, the radiologist recorded his findings and diagnosis, and compared these reports with the original reports from the digitized images. Discrepancies in film interpretation were recorded. In the first stage of the study, discrepancies in film interpretation were detected in a total of 19 films, or 5.4% of the sample population.

The second phase of the comparison study required re-reading of both the digitized images and the original films for those examinations for which discrepancies were found. The purpose of this phase was to determine if the identified discrepancies were caused by loss of detail or changes attributable to the digitisation process, or if they were caused by other factors - such as reader error or reader variation within normal limits. This phase was conducted by a second radiologist.

The second radiologist concluded that in 15 cases, discrepancies were concluded to be due to factors unrelated to the digitisation process (i.e. to reader variation in interpretation of minor details which did not affect diagnosis). In the remaining four cases, the radiologists concluded that discrepancies in film interpretation were due to changes in image detail as the result of the digitization process. In two of the four cases there was a significant discrepancy in the information available for interpretation, which could have affected the diagnosis. In the other two cases, the discrepancy was not significant and did not affect the diagnosis.

Results of "double read" study

	Guysborough.	Sheet Harbour	Total.
Sample size	233	119	352
Number, (%) of discrepancies detected	11 (4.7%)	8 (6.7%)	19 (5.4%)
Number, (%) attributable to loss of detail	3 (1.3%)	1 (0.8%)	4 (1.1%)

The cases included:

1) Views of the rib cage in which the original films revealed old rib fractures and repair which was not apparent on the digital images. There were three possible interrelated causes for this loss of information: (1) an 8-bit depth limited the number of shades of grey available; (2) the film quality was less than good on the original films; and (3) inability to highlight the images in the digital format (as with an intense light on the original film).
2) An x-ray of the knee showing changes of early osteoarthritis where detail seen on the digitized image was not seen on the original film. Calcification in the menisci was visible on the digitized image but was not seen on the original films.
3) A calcific deposit in the right shoulder seen more clearly on the original films due to better illumination on the view boxes. This did not affect the diagnosis.
4) A chest x-ray in which fine interstitial detail was not seen as clearly on the digitized image. It was felt that the 8-bit depth limited the number of shade of grey available. This did not affect the diagnosis.

Four discrepancies out of 352 represent a rate of variation of 1.1%. Using binomial probabilities, at a 95% confidence interval for the rate in the underlying process, the rate of variation in the underlying process is no higher than 3%, given that the observed variation rate in the sample was 1.1%.

The consulting radiologist believes that teleradiology appears to be a reliable and accurate means of conducting routine radiological examinations. It is recommended that a second high resolution monitor is necessary to make comparison of current and previous films more efficient and effective, and that image viewing should be to a 12-bit depth to increase the number of shades of grey available. It was also noted that the quality of the original films affects the quality of the interpretation, so a quality assurance program would have to be implemented at all teleradiology sites.

6.6.4 Summary of Referral Site Focus Group Meetings and Individual Interviews

Focus group evaluation meetings and interviews were held in Guysborough and Sheet Harbour upon completion of the teleradiology pilot project. These were conducted with referring physicians, radiology technologists, and hospital administrators, to determine acceptability of the teleradiology services. A summary of these findings related to the acceptability of teleradiology services is included in the following:

1) General findings for all sites:

- ⇒ Technical and transmission problems, most of which could be attributed to the growing pains of a new system, did interfere with use of the system and transmission of images on various occasions. As a result, extensive system maintenance was required. Problems decreased as the project progressed.
- ⇒ The software was not easily navigated, especially at the consulting site.
- ⇒ Film transmission time was too lengthy.
- ⇒ Additional personnel time is required on the part of various participants - technologists to scan radiographs, fax requisitions, troubleshoot, etc.; the consulting radiologist to view and manage films (although this decreased with experience), and co-ordinate after-hours service; consulting site secretary to provide system co-ordination, support and documentation.
- ⇒ The service requires exceptional co-ordination at the consulting site, to ensure a smoothly functioning process, quick and easy contact by the rural sites, efficient resolution of problems, and the presence of system-trained radiologists on a 24-hour basis.
- ⇒ The use of fax for transmission of patient requisitions to the consulting site and the return of patient reports was not a dependable communications mode.
- ⇒ Introducing a new patient information system to the QEII during this project caused some confusion in patient reporting, as teleradiology patients were part of this data system.
- ⇒ The referring physicians were pleased to have their patients' radiographs remain on site.

2) Guysborough site:

- ⇒ Receiving rapid reports in emergency situations was of great benefit and proved to be the greatest advantage of teleradiology.
- ⇒ Consultation with the radiologist was valuable and also streamlined the healthcare process for patients urgently needing specialist consultations.
- ⇒ Teleradiology provided a more flexible schedule for sending radiographs. Reports on routine examinations were generally received faster by teleradiology than by the traditional system.
- ⇒ The physicians and technologist felt that the system could be depended upon, and that it provided support to rural physicians.

In summary, it was apparent that Guysborough physicians and technologist, upon the completion of the four-month trial, were satisfied with the service.

3) Sheet Harbour:

- ⇒ In contrast, Sheet Harbour participants were generally unsatisfied with the teleradiology services. The main reason for this appeared to be that they were very satisfied with the radiology service received from the Dartmouth General Hospital. In retrospect, it was a serious mistake to interfere with these established and valued referral patterns.
- ⇒ Several other factors contributed to their dissatisfaction: inability to utilize teleradiology in an emergency, lack of confidence in the accuracy of the

teleradiology system due to potential discrepancies identified by visiting radiologists from the Dartmouth General, dissatisfaction with the repeated technical problems which delayed project initiation, unexpected transmission problems when the network was mistakenly disconnecting, and the sense that a six-week pilot project was not a long enough period to resolve these issues.

4) Consulting radiologist
   - ⇒ This is a satisfactory way to provide a radiology service to a rural site.
   - ⇒ Traditional radiologist workloads needs to be adjusted to accommodate the additional demands of teleradiology.
   - ⇒ Support services are required at both rural and consulting sites. Coordinating services are needed at the consulting site.
   - ⇒ As in traditional radiology, the level of competence of the technologist has a direct impact upon the quality of the films received.
   - ⇒ Training of all consulting site radiologists and residents is required in order to cover after-hour emergencies. This is an extensive undertaking in a department the size of that of the QEII. Simplifying the software would enhance this process.

6.7 Conclusions

The conclusions are summarized by project goals.

1) Technical Quality
   - ⇒ The system as it was installed initially had major operational and technical deficiencies. The system finally developed was acceptable.
   - ⇒ In a larger implementation the diagnostic image interpretation software should have customized image manipulation presets.

2) Diagnostic accuracy
   - ⇒ Three discrepancies out of 352 represents an misdiagnosis rate of less than 1%. At a 95% confidence interval for the rate in the underlying process, using binomial probabilities the misdiagnosis rate in the underlying process is no higher than 3%, given that the observed misdiagnosis rate in the sample was just under 1%.
   - ⇒ The consulting radiologist believes that teleradiology appears to be a reliable and accurate means of conducting routine radiological examinations.

3) Acceptability to those participating in the teleradiology service
   - ⇒ Teleradiology can provide a reliable service to rural physicians, although technical and other operational support is required. It is especially valuable in emergency situations.

4) Impact upon quality of patient care and healthcare outcomes.
   - ⇒ Teleradiology in emergency situations can dramatically improve patient care and health status.

⇒ The provision of care for patients diagnosed with serious diseases can be facilitated by the consulting radiologist through immediate liaison with specialists. Thus, those patients most in need of immediate care, receive it.

5) Impact upon access to healthcare.

⇒ Access to healthcare was increased in emergencies and urgent situations.

⇒ Speed of routine radiology services was increased for Guysborough, but not for Sheet Harbour.

⇒ It was not possible to compare the number of examinations performed using teleradiology with the number performed for the same period in each community last year. Guysborough referred more patients to St. Martha's in the previous year partly because they only had access to a part-time x-ray technician. In Sheet Harbour, all films were not transmitted via teleradiology during the pilot project, as the visiting radiologists continued to do some reads while onsite.

6) Impact upon existing institutional operating and support processes.

⇒ Dependable and efficient support systems are required at all sites.

7) Impact of teleradiology upon the cost of healthcare for the rural and consulting institutions, the public, patients.

⇒ Preventing patient transport by ambulance in emergencies could off-set some of the increases in costs (see Section 9).

8) Real/ potential effects upon the delivery of healthcare in Nova Scotia.

⇒ Teleradiology could be an effective way to provide radiology services to under- served healthcare institutions in Nova Scotia. It could reduce the need for radiologists to be physically located in all areas of the province. It is especially valuable in the provision of emergency services

⇒ Teleradiology could enhance and/or alter referral patterns to other specialists, as the consulting teleradiologist could potentially serve in a "triaging" or "service co-ordinating" role.

⇒ Teleradiology can provide support and reassurance to physicians in rural areas.

⇒ Teleradiology has the potential to provide more efficient care for patients through improved transmission of clinical data and communication between healthcare providers.

⇒ Teleradiology, like other telemedicine applications, could also be supportive of rural communities, by allowing patients to stay in their communities for diagnosis and treatment as opposed to being referred to regional hospitals or tertiary hospitals.

6.8 Recommendations

Recommendations for improving the teleradiology service as provided in the pilot project include:

1) Overall

- ⇒ Further improve the technology to improve speed and ease of use.
- ⇒ Assess support required at each site prior to initiation of teleradiology and put identified supports in place. Administrative and co-ordination support are strong needs.
- ⇒ Relieve the consulting radiologist of other responsibilities to allow time to manage the teleradiology service (e.g.., to assume the additional patient load, co-ordinate the services of the consulting site, provide training, resolve quality issues as they occur, etc.).
- ⇒ Resolve questions regarding the ownership and storage of patient records, and patient identification.
- ⇒ Replace the fax system with a more efficient mode of transmitting patient documentation.

2) Recommendations for an extended teleradiology service in Nova Scotia

- ⇒ Ensure that all participants are kept well informed regarding the implementation of teleradiology, including those hospitals whose traditional provision of radiology services may be curtailed.
- ⇒ Do not disrupt existing satisfactory referral patterns.
- ⇒ Assess teleradiology needs of sites before implementing teleradiology.
- ⇒ Weigh the cost of teleradiology against the more intangible savings of support for rural physicians and improved emergency care. This may be one more factor in resolving issues around recruitment and retention of physicians in rural areas.

7. Dermatology Specialist and Support Services

7.1 Overview

This section describes the teledermatology pilot. The purpose of this aspect of the pilot project was to provide an easily accessed dermatology consultation service for family physicians in the rural sites. The teledermatology component of the pilot project linked the QEII Dermatology Department with three referring sites - Guysborough, Sheet Harbour, and North Sydney. The intent was to provide clinical consultation in dermatology. The teledermatology pilot extended from May to August, 1996.

In the following sections background information is given on teledermatology, the goals of this portion of the pilot project are identified, the teledermatology process is described, and the evaluation process and results are detailed. The final section give recommendations. Technical information on the system used for the teledermatology pilot is described in Section 4, details on the technical assessment are in Section 7, and the cost analysis and summary is in Section 9.

7.2 Literature review

Although much literature is available in the general area of telemedicine, much less has been published which is specific to teledermatology. Most published work addresses specific components of teledermatology. Schiff and Stiller (1994) report upon a study comparing photographs taken with a digital image camera, which is used in teledermatology, with those taken with conventional 35 mm cameras. They found that the photographs produced with the digital image camera compared favourably with those taken by conventional camera, producing good quality images within seconds. Through a modem, these can be readily transmitted between sites.

Diagnostic quality and accuracy of the transmitted digital images are, understandably, of the utmost concern. One study compared the relative informativeness of 180 digital image formats and 35 mm slides for a spectrum of cutaneous lesions, using randomized procedures (Perednia, Gaines and Butruille, 1995). The results indicated that the informativeness of the colour slides and the digital images were statistically similar.

Teledermatology is generally conducted using either "store and forward" techniques only, or by using "real time" interactive video, which may be supplemented by digital images. "Store and forward" teledermatology is conducted by taking still-life images at the rural site using a digital camera, downloading them to a computer, and transmitting via modem and phone line to the consultant site. Perednia (1996) briefly describes a "store and forward" system in Oregon, results of which to date indicate that the dermatologist has been able to contribute useful diagnostic information to the primary care physician. From late February, until January, 1996, 55 consults had been seen by this method (Perednia, 1996, p.19).

Perednia and Brown describe the design of a comprehensive longitudinal teledermatology research project undertaken by Oregon Health Sciences University (1995). The purpose of the study was to demonstrate how teledermatology, using "store and forward" technology, can enhance the provision of dermatology care in rural areas of the United States. The first component of the project was basic research to confirm the ability to make accurate diagnoses using digital images and to define the minimum technical specifications required to ensure that information which is important for diagnosis can be captured. Following this, the utility of the teledermatology system developed in the basic research phase was be evaluated in a two-year trial. Objectives for the second phase would be to determine whether the technology will improve the process of healthcare delivery by (1) enhancing information flow and reducing isolation, (2) improving the provision of dermatologic care, and (3) increasing the primary care physician's knowledge of dermatology (Perednia and Brown, 1995, p.46). Research on a scale such as this is necessary to identify both the technological standards for telemedicine and the larger question of its impact upon the healthcare system.

Since 1989, teledermatology services have been offered to general practitioners in northern Norway via a collaborative project between the University of Tromso and Norwegian Telecom Research called "Telemedicine in North Norway" (Rinde, Nordrum and Nymo, 1993). The overall project was designed upon assumptions that telemedicine is not just a question of utilizing the appropriate technology, but it also raises equally important questions about organizational and delivery processes of healthcare, and professional issues. Teledermatology in this project is conducted by interactive videoconference between the rural site and the University Hospital of Tromso. The general practitioner accompanies the patient during the video consult, and both physician and patient give an account of the condition to the dermatologist. The dermatologist views the skin site in question via live image and/or high-quality still image. The diagnosis is worked out collaboratively between the general practitioner and the specialist, and throughout the processes of diagnosis and definition of treatment, it has been found that the dermatologist adds to the knowledge of the general practitioner. This approach has been very favourably received, with the result that it has become routine in teledermatology consults, and the service is being expanded to other sites.

Warren et al (1995) undertook a small comparative unblinded observational study to evaluate the usefulness of telecommunication technology, in this case interactive video conference, in the diagnosis of dermatologic conditions. Twenty-two patients were diagnosed using videoconference technology, and again, three days later, by direct face-to-face consultation. The telemedicine and direct diagnoses and differential diagnoses were found to be the same in 21 of the 22 cases. In the one case, the telemedicine differential included more disorders than on direct examination. The examiner reported that in some instance palpation of lesions might have been helpful in diagnosis, but the differential diagnoses were similar even in these cases. The researchers concluded that telemedicine did provide a reliable means of evaluating and diagnosing dermatologic conditions.

Lowitt (1996) also undertook a study in Baltimore to compare the acceptability of dermatology consult by interactive videoconference with traditional in-person consultation. This study indicated that patients were very accepting of the technology, while physicians reported some technical problems. These included problems with the focus and resolution, the ability to examine the skin, and the ability to visualize necessary body areas. In a second study, preliminary reports indicate that physicians reported confidence in 98% of their in-person diagnoses, but only 85% of the diagnoses derived by videoconference. Overall agreement between video and live exams was 80%. Based upon their results, investigators are expanding the provision of teledermatology services. They also stress the importance of good technical support, and the need to work out technical "glitches" in the early phases of a project. Finally, Lowitt stresses the value added by interactive videoconference to the patient consultation and diagnostic process, as opposed to using only "store and forward" technology.

7.3 Goals

The goals of the project were to determine the:

1) Technical quality of the teledermatology consult by:
    - ⇒ determining the quality of the visual image transmitted;
    - ⇒ identifying problems with history taking for the consulting physician;
    - ⇒ identifying difficulties in conducting a physical examination;
    - ⇒ identifying any particular dermatological lesions that are more difficult to diagnose using this technology; and
    - ⇒ identifying any minor investigations that could not be demonstrated with this modality ie. dermographism etc.
2) Acceptability of teledermatology consultation to the patients, referring physician, consulting physician by:
    - ⇒ identifying patient acceptability of and satisfaction with the technology, patient support prior to and during the consultation, patient-physician relationship, impact upon non-clinical factors such as travel time and personal cost;
    - ⇒ identifying referring physician acceptability of and satisfaction with speed and ease of referral, reliability of the process, communication with consultant, patient follow-up. For those referring physicians who attended the consultation, these included ease of operating the equipment, value of direct communication with consultant, and CME value of attending the consultation; and
    - ⇒ identifying consulting physician acceptability of and satisfaction with ease of using the equipment, impact upon patient-specialist relationship, logistical

support for consultation process including booking process, history taking, and physical examination.

3) Impact of teledermatology upon quality of patient care and health outcomes by:
    - ⇒ identifying instances where the use of teledermatology had an impact upon the quality of care, patient status and/or health outcomes, as compared to the traditional consultation service.
4) Impact of teledermatology upon access to healthcare by:
    - ⇒ determining the availability and timeliness of services as compared to the traditional service; and
    - ⇒ assessing impact upon the volume of requests for dermatology consultation.
5) Impact of teledermatology upon institutional operating and support processes by:
    - ⇒ identifying the support activities and resources required to implement teledermatology consultations (e.g., patient booking and registration processes, patient support, transfer of patient documents, etc.); and
    - ⇒ identifying unforeseen problems with and barriers to the efficient functioning of the service.
6) Impact of teledermatology upon the cost of healthcare:
    - ⇒ for the patient (e.g., distance travelled, travel expenses, time lost from work, other expenses)
    - ⇒ for the referring physician and the referral institution (telecommunications and equipment costs, support services)
    - ⇒ for the consulting physician and site (telecommunications and equipment costs, consultants time, fee, etc.)
7) Real/Potential effects upon the delivery of healthcare in Nova Scotia by:
    - ⇒ identifying how patterns or systems of care could be altered by the adaptation of teledermatology.

7.4 Teledermatology Consultation Process

Site visits were made by the consulting dermatologist to two of the three rural sites prior to the initiation of the project. The purpose of these visits were to meet with the physicians who would be referring patients to the service, and in some cases the hospital administrator, to assess their needs and expectations prior to the initiation of the project. The data collected were used to design and develop the teledermatology pilot project.

7.4.1 Booking

Each of the three rural areas were allotted a specific time of the week for their patient consultations - their "teledermatology clinic". The time chosen corresponded to the dermatologist's schedule. Monday mornings were reserved for Guysborough, Wednesday afternoons for North Sydney and Thursday mornings for Sheet Harbour.

All consultations were booked through the dermatologist's office. The dermatologist requested a consultation letter from the referring physician prior to accepting a patient for a telemedicine consult. For North Sydney, appointment times were then faxed back to the hospital Outpatient Department (OPD), and the OPD phoned the patients to inform them of their appointment times. In Guysborough and Sheet Harbour, individual physicians were notified of their patient's telemedicine appointment and they looked after the notification of their patients through their offices.

7.4.2 Charts

New, non-QE II hospital patients required new charts for each consult. For this pilot, patients were not considered to be patients of the QE II hospital but rather patients of the referring hospitals. For this reason, telemedicine consults could not be incorporated into QEII charts. The charts were kept in the dermatologist's office to prevent them becoming mixed with hospital records.

7.4.3 Consent forms

In addition to filling in hospital consent forms, patients taking part in the pilot project in dermatology were asked to sign a separate consent form. This form specifically referred to the teledermatology project.

7.4.4 System operation

In Guysborough and Sheet Harbour, the family doctors attended the consultations and operated the system. In North Sydney, a nurse was hired to run the equipment and to accompany and instruct the patient.

7.4.5 Conducting the Consultation

Using videoconferencing, a patient history was taken to supplement the referral letter already received. Information received from the patient was supplemented by the family physician if the latter was in attendance. The physical exam was performed using the high resolution camera - a fixed camera which could be used to show a limb or rotated to visualize the face or body. A dermatoscope camera, which was used for very small lesions, was available at the Guysborough site for a few consults. The assistant at the rural site (either the nurse or family physician) aided in the physical exam by positioning the patient and palpating lesions when requested.

Digital photographs were taken of areas requested by the dermatologist. These were transmitted to the Halifax site where they were reviewed by the dermatologist. The transmission time varied from two to seven minutes depending upon the number of pictures. The reviewing time by the dermatologist averaged two to five minutes. During the transmission and viewing time, the videoconferencing camera was muted (i.e., dermatologist and patient could not see each other) but the two sites were still linked by audio so that questions could be asked as necessary.

Following the viewing of the photograph, the patient and attending physician or nurse would then be again visible on the monitor screen. Diagnosis, investigation and treatment would be discussed.

7.4.6 Follow Up

All consultations were followed up with a consultation letter to the referring physician. North Sydney Hospital requested a copy of the consult letter as they considered that, as the patient had been seen in their hospital, the letter was required to complete the patient's chart. In urgent cases, diagnoses and treatment were faxed or phoned to the referring physician once the patient had been seen. If the GP was in attendance then all information was verbally transmitted during the conference. This was also followed by a consultation report to the referring physician.

7.5 Evaluation Methods

The overall evaluation of the program was based on an assessment of the following:

1) Patient demographics and clinical diagnoses.
2) Assessment of accuracy of diagnosis as determined by diagnostic tests and procedures, including skin biopsies, mycology, and patch testing in a number of patients, and by follow up office consultation either by the consulting dermatologist or another dermatologist.
3) Number of urgent referrals.
4) Consulting dermatologist, patient, and referring physician questionnaires completed following the consultation.
5) Focus group evaluation meetings and individual interviews with participating physicians and other participants held upon completion of the pilot.
6) Identification of costs related to teledermatology.

7.6 Assessment of Accuracy of Diagnoses

7.6.1 Patient Demographics

There were a total of 66 video conference consultations. Although the majority of patients were seen as out-patients, some in-patients were also seen by teledermatology. Of these 55 were new patients, and 11 were return visits. New consultations per site were distributed as follows:

18 ...Guysborough
15 ...Sheet Harbour
22 ...North Sydney

There were 28 female and 27 male patients with ages ranging from 18 months to 89 years (11 were children under the age of 16, and 6 were 60 years old or older).

7.6.2 Clinical Diagnoses

A total of 41 different diagnoses were made. A number of patients had more than one dermatologic condition. The different diagnoses and the number of patients diagnosed with each is itemized as follows:

Clinical diagnoses made during the Teledermatology Project

Diagnosis and number of patients diagnosed with this condition	Diagnosis and number of patients diagnosed with this condition
1 Actinic keratoses	1 Solar lentigos
1 Molluscum contagiosum	2 Tinea versicolor
3 Irritant contact dermatitis	3 Actinic keratoses
3 Allergic contact dermatitis	1 Congenital melanocytic nevus
2 Seborrheic keratoses	2 Rosacea
1 Post inflammatory hyperpigmentation	1 Keratose pilaris
1 Erysipelas	1 Frictional papular dermatitis
1 Tattoos	1 Pityriasis rosea
1 Ichthyosis vulgaris	1 Porphyria cutanea tarda
1 Folliculitis	1 Neurodermatitis
3 Psoriasis	1 Stasis dermatitis
1 Pustular psoriasis	1 Port wine stain
1 Erythrodermaic psoriasis	1 Granuloma faciale
3 Acne	1 Discoid lupus erythematosus
1 Acne scars	2 Vitiligo
3 Granuloma annulare	1 Kaposi's sarcoma
2 Nummular eczema	1 Seborrheic dermatitis
2 Papular urticaria	1 Lichen planus
1 Atopic dermatitis	1 Stevens-Johnson syndrome
1 Photosensitivity	1 Drug eruption
1 Folliculitis Keloidalis	

7.6.3 Diagnostic Test and Procedures

Diagnostic tests and procedures were conducted to validate the diagnosis - as would have been done in an office consultation. These included:

1) *Biopsies:* Seven out of 55 patients were requested to have skin biopsies performed. The consulting dermatologist felt that this number was similar to the number performed in an average dermatology office. The biopsies and results included:
   - ⇒ Insect bites: Confirmed by biopsy
   - ⇒ Kaposi's sarcoma: Confirmed by biopsy

⇒ Discoid lupus erythematosus: Confirmed by biopsy

⇒ Granuloma faciale (benign): Clinically from the computer screen this was felt to be a skin cancer. However, the differential diagnosis was very long.

⇒ Biopsy showed a prurigo nodularis: The referring physician was concerned that it was SLE. The dermatologist was confident that it was not SLE but felt that it may be a drug eruption.

⇒ Biopsy showed folliculitis: Over diagnosed. Dermatologist felt that it may be an actinic keratoses or skin cancer.

⇒ Scalp biopsy showed seborrheic keratoses. This patient had a long list of benign and malignant tumours. However, the clinical and pathology did not correlate, and a second biopsy was requested.

Three of the seven biopsies showed that the teledermatology diagnosis was accurate. One of the seven showed that the diagnosis had been included in the original differential diagnosis. Two were overdiagnosed as possible skin cancers when they were benign. The final condition is still unknown as the second biopsy had not returned at the time of this report.

2) *Blood work:* Five of 55 patients were requested to have blood work, as follows:

⇒ Psoriasis: pre Soriatane blood work ordered.

⇒ Nodular cystic acne: pre Accutane blood work ordered.

⇒ Photo sensitive eruption: blood work suggested but results never received.

⇒ Porphyria cutanea tarda: blood work positive

⇒ Stevens-Johnson syndrome: blood work positive.

All of these investigations would have been requested if the patient had been seen in the traditional office consultation.

3) *Mycology:* This was suggested for two of the 55 patients, for the following diagnoses:

⇒ Nummular eczema,

⇒ Tinea versicolor.

However, are these were ordered by the family physician, the dermatologist did not receive the results.

4) *Patch tests:* Three of the 55 patients had to travel to Halifax for patch tests. Two of the three tests were positive:

⇒ Severe contact dermatitis of hand.(Positive patch tests)

⇒ Irritant contact dermatitis on hands. (Negative patch tests)

⇒ Hair dresser with severe allergic contact dermatitis on hands. (Patch tests positive; were read via telemedicine)

These results correlate well with usual dermatology office practice.

7.6.4 Follow-Up Office Consultations

Four of the 55 patients were seen in follow up office visits, as the diagnosis was not clear via telemedicine. These consultations were conducted by either the project dermatologist or another dermatologist. (Note: This does not include those seen for patch tests).

The diagnosis of the other dermatologist was the same as that of the project dermatologist. The remaining three were seen in the office by the project dermatologist primarily because of the severity of their disease. The diagnoses remained the same. One patient with Stevens-Johnson syndrome was referred to an ophthalmologist. This is usual practice.

7.6.5 Urgent Referrals

Five of the 55 patients were seen urgently - booked and conducted the same day. Three of these patients were already in hospital. Their diagnoses included:

1) Erysipelas;
2) Stevens-Johnson syndrome;
3) Classic Kaposi's sarcoma;
4) Bullous porphyria cutanea tarda; and
5) Bullous allergic contact dermatitis-poison ivy.

For three of these patients, teledermatology greatly speeded up their diagnosis, investigation and treatment. In the remaining two situations, the dermatologist was able to reassure the referring physicians that the treatment they had prescribed was appropriate.

Two patients were admitted directly to the QEII, following a telemedicine consultation:

1) Erythrodermic psoriatic: admitted because the patient was very sick
2) Classic Kaposi's sarcoma: admitted for radiotherapy following a positive biopsy.

7.6.6 Summary

In summary, the dermatologist felt that the accuracy of diagnosis by teledermatology was within acceptable limits as compared to traditional office consultations.

7.7 Evaluation Results

7.7.1 Summary of Consulting Dermatologists Questionnaires

A questionnaire was completed by the consulting dermatologist upon the completion of each patient consultation. The following is a summary of the results:

- *Time taken for consultation:* This includes time for videoconferencing, transmission of photographs and discussion of diagnoses, investigation and treatment. The recorded times did not include the time to dictate letters, phone or fax reports as this time would be similar to time taken in office consults.

  - ⇒ New consultations: Mean time: 31.3 minutes; Range: 10 - 70 minutes
  - ⇒ Return patients: Mean time: 24.0 minutes; Range: 10 - 55 minutes

  The time for consultation by teledermatology is longer than for average office consultations. This time included extra time spent resolving technical 'glitches' and the time for transferring and reviewing photographs. The length of time taken improved throughout the project as all staff became familiar with the running of equipment.

- *Evaluation of the technical running of the consultation:* This included the dermatologist's assessment of the booking process and patient preparation, the skills of the assistant, and technical quality. This pilot project's patient registration went relatively smoothly, and patient bookings were well organised. This was contrary to the reports of other investigators who had commented that 5 to 25 calls had to be made to book a patient (Field, 1996). The rural site was easily accessed most of the time.

  As only a single ISDN line was available for communications, the real-time picture was often not adequate for making diagnosis. As a result most diagnosis were made after receiving the snapshots taken using the high resolution camera. In addition, the lighting on the dermatologist was inadequate, due to the poor lighting in the room in which the telemedicine station was located. The lighting at the rural sites was better. The quality of the sound was good, but the audio lag was disconcerting. However, the dermatologist became accustomed to this throughout the course of the project. A mute button was very useful at both ends.

  The rural site assistants and consulting dermatologist had generally poor technical and computer skills at the initiation of the project, in spite of receiving training. Taking and managing digital snapshots using the high resolution camera was one of the most difficult tasks, and many were lost in transmission or were received and then misfiled. All this improved immensely as everyone's skill improved.

- *Evaluation of history taking via telemedicine:* History taking via videoconferencing is different. It does not compare to a face-to-face, in-person interaction. Because of this, both dermatologist and patient were awkward to start with. Once the consultation started then everyone relaxed. Overall, the interaction between patient and physician was not compromised by the computer. Several of the patients felt it was a great deal of fun. Surprisingly, children became mute when faced with the computer, and their parents did most of the talking.

- *Physical Examination:* The physical exam was done with the high resolution camera and in some cases a dermatoscope camera. In all cases the patient was a very active participant as they had to be put into sometimes awkward positions. Initially the high resolution camera was up on a table. Elderly people had trouble elevating their legs on to the table. Lesions on the head were difficult to see. Patients had to lean over or be placed on a stretcher and rolled under the document camera. Usually, the assistant was able to follow the directions of the dermatologist to bring the right part of the anatomy into the computer screen.

  Physical examination other than that accomplished visually had to be conducted by the healthcare professional accompanying the patient. This included palpation of the site, accurate assessment of elevation or depression, detection of odours, and examination of other organs. In general this went well.

Morphological diagnosis by teledermatology; i.e., identifying which types of lesions are difficult to interpret, was also an objective of the study. Acute diseases in general presented no problems. Bullae, vesicles, papules, pustules, nodules, depressed scars are all easily visible. There is a problem with very small lesions especially when there is no dermatoscope available. Erythematous macules and patches alone are difficult. The colour is hard to determine if the lighting at the rural site is poor. To determine elevation of a lesion it is necessary to shadow it which can present a problem. Poor resolution of the computer screen makes the borders of lesions fuzzy and it is hard to determine the edges. The high resolution camera was fixed - which made viewing of the trunk and lower extremity awkward for the patient. Visualizing the oral mucosa is impossible.

- *Overall evaluation of the teledermatology consult:* The dermatologist was confident that most patients' diagnoses could be made without seeing them in office consultation. The dermatologist also felt that seeing the patient "live" via videoconference added value to the consultation. These findings concur with those of Rinde, Nordrum and Nymo (1993) and Lowitt (1996).

7.7.2 Results of Patient Questionnaires

Patients who used the teledermatology consultation service were asked to complete a short questionnaire designed to measure their degree of satisfaction with the service, following their consultation. Patients appeared very satisfied with the service, with their ratings of variables ranging from a low of 4.21 to a high of 5.00 on a 5-point Likert scale. The lowest rating (4.21) was for the organization of the appointment and registration. This is supported by reports in the literature stating the organizational, administrative type of functions related to telemedicine often cause more of the problems and dissatisfaction than the actual technology and the consultation. (Field, 1996)

It is most notable that all respondents strongly agreed with the statement that "This technology is of value to me and my community". This finding was corroborated by data collected in the physician focus groups and in interviews with other project participants; i.e., they reported that patients enthusiastically verbalized that teledermatology was a valuable service both personally and for the community, primarily because it saved patients the time and expenses of travel.

An additional, but difficult to measure "expense" of travel to Halifax for an appointment was identified by patients as the personal fatigue and/or stress caused by the long drive and unfamiliar city travel. This is especially demanding for seniors, and for parents with young children.

7.7.3 Results of Referring Physician Questionnaires

A total of 14 family physicians from the three communities referred patients for teledermatology consults. Ten physicians completed a brief questionnaire designed to identify their degree of satisfaction with the teledermatology service following an individual patient referral to the service. A total of 13 questionnaires were completed (three physicians completed two questionnaires).

The respondents "agreed" to "strongly agreed" with all descriptive statements. It is notable that the most highly rated agreement was with the statement, " Teledermatology is of use in my practice" and that all agreed that "This form of medicine is of use to physicians in rural medicine". This matched well with the intent of the project which was to determine if teledermatology did provide support to rural physicians.

Several responding physicians added comments. Two comments identified technical difficulties encountered while using the camera and during site access. One consult was of an emergency or urgent nature, and the referring physician commented that, "It was an excellent service; however, we need follow up". Another physician also reported that it was "an excellent service". One physician, who referred only one patient, stated that he would like to see the program continue for another trial period so that he could make greater use of it and evaluate it more effectively.

7.7.4 Focus Group Evaluation Meetings and Individual Interviews

Two focus group project evaluation meetings were held, one with the referring physicians in Guysborough, and the second with physicians, the hospital administrator and director of nursing in Sheet Harbour. Interviews were held with the administrator in Guysborough and the nurse responsible for the patient registration, booking and support in North Sydney. The data collected is summarized below. (Note: the referring physician accompanied the patient in Guysborough and Sheet Harbour during the consult, and the nurse who was interviewed was the one who accompanied the patients in North Sydney.)

1) *What are the advantages of teledermatology?*

   ⇒ The main advantage is to patients who do not have to travel to Halifax. It is a great relief for them, not only time-wise and financially, but because many patients find the long trip and navigating metro Halifax both physically tiring and mentally stressful. It makes a very long day for patients travelling from any of the three sites, as they have to leave early in the morning and do not get home until evening, while the appointment is only a few minutes. It is especially difficult for seniors and those with additional health problems. The trip is extremely difficult for those who have to travel by public transit. Furthermore, some patients with chronic conditions have to travel to Halifax for consultation on a regular basis. In general, it was felt that patients were truly delighted by the service.

   ⇒ During the videoconference, the dermatologist saved several patients additional trips to Halifax by co-ordinating appointments, when a trip could not be avoided. She provided advice on where to stay close to the hospital if overnight accommodation was required.

   ⇒ Speed of referral (one week as opposed to 4- 6 weeks), and the benefits which early treatment provides for the patients (faster healthy outcomes).

⇒ Two patients with urgent conditions (drug reactions) were seen immediately, with excellent results. Teledermatology also eliminated the need for these patients to be transported by ambulance to the city.

⇒ It was valuable to speak directly with dermatologist, to provide a complete patient history and to receive immediate feedback about the patient's condition and treatment plan.

⇒ Good learning experience for GP's .

⇒ Having photographs of the patients' dermatology conditions stored in the computer proved beneficial, as they were used to compare the patient's progress on subsequent visits.

2) *What are the disadvantages of teledermatology?*

⇒ Time intensive on part of GP.

⇒ No reimbursement for GP's time.

⇒ A single ISDN line bandwidth made communication awkward at times (especially for one GP).

⇒ Technical problems with camera - the high resolution camera was not suitable for viewing various parts of human anatomy. Photographs could also be taken in advance and send to the consultant prior to consultation.

⇒ Software should be more user-friendly. It was difficult to navigate.

⇒ Co-ordination of the teledermatology process at both rural and host sites, as not everybody knows what to do. Need a designated person responsible for this function at each site, who also communicates with the other sites as necessary.

⇒ Need a dermatoscope for better visualization.

⇒ Cost to the hospital of this service; i.e., monthly telecommunications charges.

3) *Did your impressions of teledermatology change as the pilot project progressed? If so, how?*

⇒ Became more accustomed to technology; knew what to expect.

4) *How would you describe your "comfort level" with teledermatology?; i.e., do you feel you can depend on it?*

⇒ Comfortable with, in spite of technical glitches. Can depend on it.

⇒ Enjoyed it and learned from it.

5) *Did teledermatology have any impact on your practice or the way patient care is provided?*

⇒ Need support person to reduce time demands upon GP.

⇒ However, a valuable leaning experience.

6) *Did teledermatology have any impact on your professional communication patterns?*

⇒ Valuable communication with consultant.

7) *Did teledermatology have any impact on the quality of care/ patient status/ health outcomes?*

- ⇒ Patients were able to see the consultant more quickly, and thereby received relief from their dermatology health problems more rapidly. In two urgent situations, patient problems were resolved more quickly than if patient had to wait for transport by ambulance to Halifax. The rapid consults in these situations also prevented the stress caused by ambulance transport.
- ⇒ Not having to travel to the city reduces physical and emotional stress for many patients. This can have a positive impact upon their health status, especially for the elderly and those who have other healthcare problems.

8) *Did teledermatology have any impact on the cost of care for patients, institutions, the public*

- ⇒ Notable savings for patient, as not having to take a day and travel to Halifax.
- ⇒ "There is high unemployment and a lot of poverty in Cape Breton, and this service saved a lot of people a lot of money."
- ⇒ Cost of lines, support staff.

9) *Did teledermatology have any impact on patient access to care*

- ⇒ Increased patient access. Could have impact of increasing referrals. On other hand, GP'S learning through the consultation process may decrease dermatology referrals as they become more knowledgeable about dermatology.

10) *Would you be willing to use the service again?*

- ⇒ Yes, for the sake of the patients.
- ⇒ Especially if we had additional bandwidth to improve technical quality.

11) *What recommendations would you make, if any, for the implementation of teledermatology on a broader scale in Nova Scotia?*

- ⇒ Increase the telecommunications bandwidth. (It's a worthwhile service for patients, and for GP learning.)
- ⇒ Provide support staff in long term.
- ⇒ Do not make extra demands on existing hospital staff, as they are already stretched to the limit due to down-sizing.
- ⇒ Need to find way to reimburse GP's for attending the consult.

7.8 Conclusions

Conclusions drawn from the evaluation results are summarized below.

1) The accuracy of the teledermatology diagnoses as determined by biopsies, blood work, patch tests and "in office" repeat visits, was similar to the accuracy of those of a traditional office consultation practice; i.e., accuracy was acceptable. Also, the videoconferencing communication added a valuable dimension to the consultation, as opposed to using purely "store and forward" systems as reported in the literature (Perednia, 1996; Perednia and Brown, 1995).

2) The technical operation of the system did not significantly interfere with the patient consultation. In summary:

   ⇒ Visual quality was diminished by using only a single ISDN line and a medium quality computer monitor.

   ⇒ Lighting was a very important consideration. This applied to lighting on the dermatologist, the patient, and the affected areas.

   ⇒ The high resolution camera was not designed for physical examination, and positioning the patient to visualize some body areas was difficult.

   ⇒ Software was difficult to navigate.

   ⇒ Technical difficulties increased the time of the consultation.

   ⇒ Transmitting and reviewing photographs added 10-15 minutes to the consultation.

   ⇒ History taking was satisfactory via videoconferencing.

3) Acceptability of teledermatology consultation by patients:

   ⇒ 100% of patients felt teledermatology was of value to them and their community.

   ⇒ In addition to the financial savings derived from not having to travel to Halifax, patients identified benefits in physical and mental well-being.

   ⇒ Patient-physician communication was not compromised by the technology.

4) Acceptability of teledermatology consultation by referring physicians :

   ⇒ All referring physicians agreed that teledermatology is of use and of value to physicians in rural practice and to those who have limited access to dermatology services.

   ⇒ Attending the consultation provided valuable communication with the consulting dermatologist and valuable CME.

   ⇒ Attending the consultation was also time consuming; there should be some method of remuneration.

   ⇒ Physicians became comfortable with the system; felt it could be depended upon.

5) Acceptability of teledermatology consultation by consulting physician:

   ⇒ This is a satisfactory way to see patients.

   ⇒ Patient-physician relationships were not compromised by the technology.

   ⇒ Technical quality, support systems and referral patterns would require improvement for teledermatology to be effective and efficient in the long term.

6) Impact of teledermatology upon quality of patient care, health status and health outcomes:

   ⇒ Five patients seen were of an urgent nature. In three instances, the healthcare status of these patients was improved dramatically as the result of being seen within 24 hours. In the remaining two cases, the dermatologist was able to reassure the referring physician that appropriate treatment was being provided.

- ⇒ Generally, patients were able to see the specialist more readily, and hence receive treatment and relief of disease conditions more quickly.

7) Impact of teledermatology upon access to healthcare:

- ⇒ Teledermatology increases access to dermatology healthcare for rural patients.
- ⇒ The tendency could develop for rural physicians to refer patients unnecessarily, simply because the service is available. On the other hand, participating in teledermatology consultations could increase the expertise of referring physicians, and thereby reduce the number of patients they refer.

8) Impact of teledermatology upon traditional operating and support processes:

- ⇒ A well-organized support system for booking patients, assisting patients during the consultation, providing technical support, and managing patient documentation at the rural site is required for the distance consultation to proceed smoothly.
- ⇒ Organizational and physical changes are required to support the consultant in teledermatology.

9) Teledermatology has an impact upon patients, healthcare institutions, the public and society.

- ⇒ Most significantly, personal cost to the patient is substantially reduced. This is particularly significant for families and for those not able to easily afford the costs.
- ⇒ Costs to the rural institution will increase to cover not only the capital, maintenance and communications charges of the telemedicine technology, but also the costs of patient booking, documentation and support. In North Sydney, where the referring physicians did not accompany the patient during the consultation, patient support was provided by a registered nurse who was hired for the hours of the teledermatology clinic.
- ⇒ Referring physicians attending the consultation need to be reimbursed for their time.
- ⇒ The time taken for a telemedicine consultation is long. Part of this is due to the taking of photographs, transmission time and the diagnostic time taken by the specialist. This may add 10 - 15 minutes to a case and will affect the number of patients the teledermatologist can see.
- ⇒ Public costs incurred by patients who receive public assistance with travel expenses for physician consultation will be reduced. Occasionally these will include ambulance transport, although this is unusual in dermatology care.

10) Real/Potential effects upon the delivery of healthcare in Nova Scotia.

- ⇒ At this time, there are a limited number of dermatologists in areas of Nova Scotia outside Halifax - the waiting period to see the sole dermatologist in Cape Breton is 6 months, while the average waiting time in the Halifax area is 8 weeks.

⇒ Existing dermatologists would be required to reduce their current number of "in office" consultations to make time available for teledermatology consultations.

⇒ Healthcare for patients in rural areas with dermatological problems would be improved.

⇒ Support would be provided for rural physicians. This support could be expanded into other specialities.

⇒ Teledermatology could have a minor economic impact upon poor rural areas, as fewer people would be required to spend their money travelling to Halifax.

7.9 Recommendations

1) Technical

⇒ Improve the technical quality by providing the equivalent bandwidth of three ISDN lines, by providing a high quality monitor for the consulting site, and a more flexible examination camera and dermatoscope for rural sites.

⇒ Make the software more user-friendly.

2) Support systems

⇒ Provide a support system at the rural site for patients and the service in general.

⇒ For dermatology, the support nurse would benefit from a 'crash' course in dermatology terminology and morphology.

⇒ The teledermatology station in the consulting site should be located within the dermatology department.

⇒ A proper room that is well lit, well ventilated and able to accommodate more than one person is required for the telemedicine work station.

⇒ When booking, regard the patient as a patient of the specialist. The chart should be located at the consulting site and consultation letters should be sent to the referring physicians. This would decrease confusion as to who is responsible for the patient and where their hospital chart would be located.

⇒ All booking should be controlled by the specialist to correspond with their schedules. Emergencies should be accommodated by other disciplines who may be using the system.

⇒ A special consent should be used for teledermatology.

3) Referring physicians

⇒ Encourage referring physicians to attend their patients' consultations, as the learning derived will improve their skills, and potentially decrease the number of referrals they make.

4) Cost

⇒ Encourage referring physicians to attend their patients' consultations, as the learning derived will improve their skills, and potentially decrease the number of referrals they make.

- ⇒ Investigate means of compensating referring physicians for attending patient consultations, such as CME credit hours.
- ⇒ Establish a schedule for reimbursing dermatologists.

5) Delivery of healthcare

- ⇒ Develop a method of remunerating attending physicians for their time; e.g., consider them like a surgical assistant.
- ⇒ To ensure that the patients who would derive the most benefit from teledermatology are the ones who actually have access to it, restrict the use of teledermatology to urgent cases or to those patients for whom travel is a real hardship.

8. Technical Assessment

8.1 Overview

One of the primary objectives of this project was to assess the capabilities of the technology and telecommunications in providing CME and clinical telemedicine services. As with the application of any new technology in an traditional environment, it is necessary to determine the appropriateness of the use of technology, and to validate the ability of the technology to perform the task - in this case:

- to present the participants with enough information to learn from broadcast CME sessions, and
- to present specialists with sufficient diagnostic quality information so that they are able to assess a patient's condition and make recommendations on patient care.

This section discusses the results of the technology and telecommunications assessment. These are presented in three sections - videoconferencing, teleradiology and teledermatology - although the technologies were integrated into a single multipurpose workstation in the rural facilities. The final section lists the recommendations arising from the technical assessment component of the project.

8.2 Videoconferencing

All sites found the videoconferencing technologies easy to use. With minimal training most users were able to power-up the telemedicine workstation and place videoconferencing calls. Using the system, all users were able to successfully participate in CME, to participate in "virtual" dermatology clinics, and to interact with specialists and others in making patient care decisions.

There were a few technical issues which impacted on the overall acceptability and usability of the system. These are detailed in the following subsections and should be considered when expanding the system into a more widespread operational model.

8.2.1 Conferencing Communications

The project was designed to use the equivalent of two ISDN lines for conferencing communications (256 kbps of bandwidth). As ISDN was not available outside of metro Halifax, most sites were installed with Switch-56 data lines - with two data lines combining to give roughly the equivalent bandwidth of an ISDN line.

In the Cape Breton Regional Hospital, the data lines were bonded through a data IMUX to provide the full bandwidth. At the three rural sites, a pair of data lines were converted to ISDN through a protocol converter. The intention was to feed the ISDN output into an IMUX to achieve the full bandwidth. Unfortunately, the ISDN IMUX did not arrive until after CME and dermatology portions of the pilot were completed. This resulted in a degraded image quality in the videoconferencing. In both the CME and dermatology trials, even this degraded image quality was found to be marginally acceptable.

There were some opportunities to use an expanded bandwidth during the teleradiology portion of the project, and during demonstrations after the conclusion of the CME and dermatology aspects of the pilot project. The clinicians involved with the project voiced a preference for the expanded bandwidth as the video quality and reduced audio lag were found to be significantly less distracting.

8.2.2 Lighting and Background Colours

Poor lighting and colouring in the rooms used for videoconferencing proved to be a significant problem in the dermatology trial, and an annoyance and distraction in the CME trial. Most of the rooms were lighted by florescent overhead lights which did not provide adequate lighting to the faces of those involved in the videoconference. There was also significant problems with the automatic light compensation on the videoconferencing cameras - which tended to set the camera for the brightest light in view of the camera and often caused a further darkening on the faces of those participating in the videoconference. This was partially corrected by implementing a backlight compensation on the cameras.

Background room colours were also found to create significant problems. Many of the rooms in which the videoconferencing occurred were painted in yellow, brown or grey while videoconferencing is most visually successful with background colours which are blue or green. This cause some significant difficulties in the videoconference image quality. In addition, many of the rooms used for videoconferencing had very "busy" backgrounds (i.e. pictures, desks, chairs, etc.) which often were very distracting to the videoconference.

8.2.3 Speakerphone

The speakerphone was not the optimal solution for the CME sessions - which tended to be in larger rooms. Often the speakerphone would be moved off the cart closer to the seminar attendees. Occasionally this resulted in the speakerphone cable being pulled out of either the computer or speakerphone, and often the cable was not long enough. In addition, the speakerphone did not provide a high quality sound. Depending on the placement of the speakerphone a "coning" or "echoing" effect was present.

8.2.4 Cart

The carts were not easy to move around the facilities - particularly across carpet, thresholds and in and out of elevators. This was primarily due to the small wheels installed on the cart (2" castors), and to the wooden construction of the unit.

8.3 Teleradiology

The technology evaluation of the teleradiology portion of the pilot was ongoing for the entire term of the project. An in-depth technical assessment determined that these technologies were adequate for the purposes of providing teleradiology services to rural sites. The technologies and processes involved in digitizing x-rays, transmitting them to a rural site, and displaying them for clinical diagnosis were optimized to best address the concerns of all those involved in the teleradiology process.

8.3.1 ACR Standard for Teleradiology

The teleradiology scanning and reading system was designed to meet the technical requirements of the 1994 *ACR Standard for Teleradiology*. The Canadian Association of Radiologists (CAR) has adopted a set of guidelines which are based on the ACR standard.

The standard calls for:

- a digitization system of 2K x 2k x 12-bit array or better and
- a display system of 2k x 2k x 8-bit or better.

There are no guidelines which describe how to convert the 12-bit scanned image to an 8-bit display image. This is typically done through the use of translation tables which "map" the 12-bit data to an 8-bit file where choice of translation table is based on the characteristics of the image that need to be modified. There are also no guidelines for image format, or compression of the image.

The 1995 Amendment to the *ACR Standard for Teleradiology* released in the summer of 1996 (in the middle of this project) added the following requirements:

- *Section IV. B. 1. Image Management:* Teleradiologic systems are imaging systems that require the use of image management for optimal performance. Both small-matrix and large-matrix (digitized radiographic films and computed radiography) systems should include:
    a. capability for the selection of the image sequence for transmission and display at the receiving site;
    b. annotation capabilities for use at the transmitting station that must include patient name, identification number, date and time of examination, institution of origin, type of examination, degree of compression (if any) and brief patient history;
    c. at the transmitting site, provision for interactive window and level function; and
    d. provision for the selection of appropriate compression for improved transmission rates and reduced archiving /storage requirements.
- *Section IV. B. 2 Transmission of Images and Patient Data:* New technology systems should include the current version of he ACR / NEMA image data format standard and the DICOM network standard.
- *Section IV. B. 3. b. Display Capabilities:* Large-matrix (digitized radiographic films and computed radiography) display stations should include:

   i. interactive window and level functions,
   ii. a magnification function,
   iii. the capability of inverting the gray-scale values of the displayed image,
   iv. the capability of rotating and flipping the displayed images,
   v. the capability of accurate linear measurements.

- *Section IV. B. 4. Patient Database:* For radiological images transmitted by teleradiology, a database should be available, at either the transmitting or receiving site, that includes:
    a. patient name, identification number, and date;
    b. type of examination; and
    c. type of images.
- *Section IV. B. 5. Security:* Teleradiology systems should provide network and software security protocols to protect the confidentiality of the patient images and data.

8.3.2 Digitizer

The VIDAR VXR-12 digitizer scans x-rays in12-bit and has the capability of applying standard or custom translation tables to map the raw 12-bit data into a processed 12-bit file structure, or to an 8-bit file for viewing. This meets the technical requirements of the 1994 ACR Standard.

During the teleradiology validation process an in-depth assessment was made of different translation tables and their applicability to different types of x-rays (soft tissue, bone, etc.). The choice of translation table was also found to be dependent on the baseline brightness or darkness of the film being scanned - which varied between the two sites. As a result of these tests, it was decided to digitize and transmit all x-rays in 12-bit unprocessed format. The processing of the images could then be done at the reading station and, if necessary, further processing could be done to enhance the desired characteristics and make the image more readable.

A second in-depth assessment was done to determine the most clinically applicable resolution at which to scan an image - where resolution is measured in dots-per-inch or dpi. The Vidar VXR-12 gives the option of scanning in either 75dpi, 150dpi or 300dpi. At the end of the technical trial a choice was made to scan all images at 12-bit, 150 dpi. This meant that each 14" x 17" x-ray generated an 8 Mbyte file which, without compression, would take about 20 minutes to transmit over a Switch-56 network. A subsequent clinical trial conducted with the radiologists did not identify significant clinical differences in diagnosis made on 75 or 150 dpi image. As 75 dpi image would only take approximately 5 minutes to transmit over the network and 150 dpi images would take approximately 20 minutes, it was decided to digitize all images at 75 dpi.

There was not sufficient time to assess compression algorithms beyond lossless compression at about 3:1.

8.3.3 Scanning Station

In the radiology referring sites, the Vidar VXR-12 digitizer was interfaced to the Telemedicine workstation and the x-ray technician ran a scanning application to digitize the films. The initial scanning process was found to be time consuming and clumsy, and averaged approximately 3.5 minutes per digitized film. Even in a very low volume site, such as Guysborough (10 to 20 films per day), this was considered unacceptable. Automation of some of the manual processes, and the automatic setting of defaults, reduced the time per film to approximately 1.5 minutes per film. Further improvements, near the end of the pilot project, allowed the x-ray technician to feed the film into the scanner, enter the patient's name and ID, select SCAN on the workstation, and then to do other work while the rest of the process for that film was automatic. This reduced the time per film to under 30 seconds.

8.3.4 Reading Station

The initial reading station configuration was a 486DX2-100 with a Windows 3.1 operating system. This configuration was slow in pulling up x-ray images and unstable - with the system "crashing" a number of times. To correct these problems, the workstation was upgraded to a WindowsNT operating system, and additional RAM was added to make the image manipulation more responsive. This greatly improved the workstation performance to a degree that the radiologists found it acceptable.

The image viewing program was found to be functional for a low volume application. With minimal training the radiologists were able to locate a patient's files, view them on the workstation, enhanced them (if necessary), and dictate their report. Although this configuration was sufficient for the pilot project, it was evident that a dual-monitor configuration would be required in a operational system. This would facilitate easier comparison of films.

8.3.5 Data Network

Initially the system design called for transmitting the x-ray files on the videoconferencing data channel. Tests on this channel measured the channel speed at around 18,000 bps and it was determined that this wasn't fast enough for transmitting digitized x-rays.

Various means of creating a store-and-forward means for moving the digitized x-rays were assessed. These included:

1) Creating the network from the ISDN lines installed for videoconferencing - when they were not being used for conferencing. This required a manual switch to change the ISDN lines from connecting to the videoconference equipment to connecting to the network equipment. In testing this network set-up it was discovered that the ISDN network equipment was capable of interrupting an ISDN conference call in progress - an unacceptable condition. It was also determined that the process of manually moving the switch and starting the file send process was easily forgotten. This could result in the day's digitized images not being sent for interpretation.

2) Installing a separate 56 kbit frame-relay network, and managing the movement of digitized x-rays using email protocols. An email server was created and managed by MT&T. The major problem with this set-up was that the time to transmit the files from the scanning to reading station was doubled as they had to first be transmitted to the email server, then from the server to the reading station. Testing also revealed significant overheads in using email to move large files around, and the files had to be "spooled" to each of the workstations.

3) Using a 56 kbit frame-relay-network, and managing the movement of digitized x-rays using the WindowsNT capabilities of the reading station and File-Transfer-Protocols (FTP). This setup ran fairly successfully for twelve weeks from Guysborough, and for six weeks with the Eastern Shore. Two failures of the network (one due to network equipment failure, and one due to miscommunication about network status) indicated a strong need for a monitored network where problems would be detected before the clinical users determined that files had not been received.

8.3.6 File Management

File management became a significant issues as teleradiology files are significant in size (approximately 2 Mbytes/film). As this system was not established to archive and retrieve the digital information, the files were purged from the system on a routine basis to make room for new files. This created problems when images needed to be retrieved for the double-reading program.

The file management required constant monitoring of the hard drive status of the teleradiology workstation. Occasionally, the hard drive became full and files had to be resent from the scanning sites after room had been cleared on the hard drive.

Operational systems must be designed with consideration of the volume of films to be sent on a routine basis, and with an understanding of the requirements to archive and retrieve images for future review. This will normally require the addition of a data server in facilities that are receiving a relatively high volume of films.

8.4 Teledermatology

The teledermatology portion of the pilot used the videoconferencing capabilities of the Telemedicine workstation, with an additional requirement to capturing and transmitting static images of patient conditions.

Although the reduced communications bandwidth at referring sites in Guysborough, Sheet Harbour, and North Sydney gave less than optimal video performance, the dermatologist, clinicians in the referring sites, and the patients were all able to effectively participate in a dermatology consult session.

As in the teleradiology technical assessment, the technologies and processes involved in conducting a dermatology consult, capturing images and displaying them for clinical diagnosis were optimized to best address the concerns of all those involved in the teledermatology process.

8.4.1 High Resolution Camera

The high resolution camera was used to take digital snapshots of patient lesions. Unfortunately, as this camera had a fixed position head, patient positioning under the camera was sometimes difficult - especially with elderly patients. In addition, the florescent lights on the camera tended to "wash out" the colour on the skin. This was corrected by using a black background and a clip-on 60 watt lightbulb to maintain as true a colour as possible.

8.4.2 Monitor

The monitor installed with the system was of medium quality and did not display true-colours. Although the system was still found to be adequate, the dermatologist expressed a strong preference for new higher quality monitors tested after the clinical trial was completed.

8.4.3 Image Capture, Transfer and Viewing

To perform a final diagnosis it was usually necessary to use the high resolution camera to take "snapshots" of the patient condition. These snapshots were taken at the rural site, and the digital file was transferred to the specialist site for the dermatologist to use when making the final diagnosis.

The initial image capture, save, transmit and review process was found to be clumsy and time consuming. Over the course of the dermatology pilot, this process was refined so that there were fewer steps, and a more functional file viewer was created and installed. This greatly increased the productivity of the dermatologist.

8.5 Data Security

8.5.1 Overview

The security of the overall system was reviewed and assessed as part of the pilot project. In determining and addressing data security issues the focus was in creating a practical, rather than a theoretical, approach.

There are three major areas of concern when determining data security:

- Authentication - ensuring that the users are who they say they are;
- Transport - ensuring that access to the system is from known/controlled channels; and
- Access control - ensuring that users only "see" what they have a right to see.

With respect to this pilot project, these areas were tested and functioned as described in the following subsections.

8.5.2 Authentication

When the system has progressed beyond the piloting phase, each of the workstations will be protected by user passwords. This was tested with the more sophisticated users to determine its viability.

In addition, the workstations themselves were installed in areas of the hospital(s) not generally accessible to the public. This will help ensure that the electronic data is not any less secure than hardcopy data stored in the area.

8.5.3 Transport

There are two methods of transporting information within the telemedicine system. The primary method is via Sw-56 or ISDN communications used during videoconference calls. This method of transporting data is extremely secure as the phone lines will "drop" if someone else attempts to "listen in" on the call. This is a function of the underlying conferencing technology and was found to work as expected.

The telemedicine workstation at the QEII site is connected via Ethernet to the radiology reading station at the QEII. This is a point-to-point connection which is completely contained within a single room and is not accessible by outside sources via any other network accesses. At present, none of the telemedicine workstations are attached to hospital networks. When this becomes a requirement, additional security precautions will be required.

8.5.4 Access control

At present the system is only accessed by those people who are using the system and only these people are trained in system operation. As the systems are based on a Windows environment, it should be assumed that anyone familiar with computers who has access to the equipment, and who knows the password, will be able to access any of the information stored on the hard drive. Beyond the pilot project phase, the security of the system must be reviewed and protocols established for maintaining baseline security processes.

8.6 Conclusions and Recommendations

The technologies installed for this project were found to adequately meet the educational and clinical requirements. A number of technical and configuration issues were identified. Many of these were corrected or improved over the terms of this pilot project.

It was determined that the systems in the rural facilities must be designed to be very rugged and easy to move around and set-up. The system components - monitor, camera, microphone and speakers - must be of high quality to present the participants with the most realistic images and sounds. Lighting, room setup and background colours were found to be significant factors in successful conferencing -

particularly in clinical situations. This was found to influence the ease of acceptability of the system by both patients and clinicians who were distracted by poor video and audio quality.

The user interface must be simple and intuitive, as most users were not frequent users, and many were not computer literate. During the pilot, workflow processes were determined and automated wherever possible to reduce the number of steps required to perform a task. This was particularly true in the clinical applications where it became evident that each clinical application would require assessment of the workflow and determination of best application of the technology.

In teleradiology, management of the digital information is a significant issue which requires careful assessment and planning before system implementation. The pilot project did not test storage and archiving of information for future retrieval, and management of the technology (i.e. computer storage and communications) was a significant effort for all involved. Future systems should carefully assess memory, communications and display requirements.

Specific recommendations resulting from the technology assessment are:

1) The user interface for all functions performed on the workstation must be simple and intuitive.
2) Lighting, background colours and videoconferencing room set-up should be considered when establishing a program.
3) Conferencing communications bandwidth must be at least equivalent to two ISDN lines (256 kbps).
4) The speakerphone should be replaced with a speaker/microphone combination. The microphone must be moveable to a table for seminars and conferences.
5) The cart in a portable Telemedicine System must be rugged, and able to move over carpet and thresholds.
6) Any new teleradiology system should meet the requirements of the Canadian Association of Radiologist and the 1995 *ACR Standard for Teleradiology* - including the data management, and image manipulation controls.
7) As assessment of compression algorithms should be done to reduce the communications times and storage requirements.
8) The reading station should be a dual monitor high performance system optimized for manipulating large images (64M RAM, 8M VideoRAM on display driver).
9) A monitored data network is necessary for store-and-forward applications like teleradiology.
10) A moveable high resolution camera is needed for teledermatology.
11) The process of capturing dermatology images, transferring and viewing them should be simple and intuitive.

Overall, the system was found to be technically viable. The installation of a single multipurpose telemedicine workstation was found to be a viable option for provision of education and clinical services. In addition, it should be noted that the same workstations could also be used for administrative purposes (i.e. meeting, interview, etc.).

9. Operational Assessment

9.1 Overview of Pilot Project Issues

From an operational perspective the pilot project ran fairly smoothly because significant short term resources were applied to manage the operational issues and processes. Although this worked well for a short project, this model can not be expanded to an operational system. This section describes the operational issues brought forth during this pilot project. A structure for an operational infrastructure is recommended in the concluding section.

9.1.1 System Training

It was difficult to determine who to train on the systems at each site as the systems were used by a number of different users, and no individual had been identified at the sites to be the key contact. This resulted in frequent visits to the sites to resolve issues that a well-trained user would have been able to identify and resolve.

9.1.2 Continuing Medical Education

There are many structural and organizational issues around each CME session. These included:

- advertising at the sites;
- scheduling the conferencing room at the Dalhousie Medical School;
- scheduling rooms at the rural sites;
- scheduling the conferencing bridge for multiple sites, including testing and registering all the sites, testing to the bridge, distributing the phone numbers, etc.; and
- at the rural sites, ensuring that the workstation was moving into the seminar room prior to the conference.

Management of these issues was shared among all those involved in this aspect of the project.

9.1.3 Teleradiology

There were many operational issues around the providing of radiologist services to a rural site. Most of these were not identified until the system was in place and problems occurred. A description of the workflow which evolved over the term of the pilot is illustrative of the problems. It should be noted that this workflow is a result of many iterations to simplify the process.

Process for having an x-ray read:

1) Physician orders x-rays.

2) X-ray technician takes and processes x-rays.
3) X-ray technician digitizes x-rays.
4) X-ray technician faxes a copy of the requisition to the consulting site.
5) X-ray technician files x-rays.
6) Radiologist checks fax machine for requisition
7) Radiologist finds files on the system and opens them.
8) Radiologist reads the films and dictates diagnosis in hospital dictation system.
9) Radiologist drops fax copy of requisition to stenographer.
10) Stenographer creates patient ID number.
11) Stenographer types report.
12) Radiologist reviews report and signs off.
13) Stenographer faxes report to technician (and referring physician)

It should be noted that the system was most acceptable to the x-ray technicians when it became a routine part of "processing" an x-ray. This worked best when the workstation was in the x-ray area, and set-up to scan x-rays as they were completed - rather than saving the x-rays to when the workstation was available. The movement of the telemedicine station to the x-ray room, connection to the digital scanner and start-up of the system took approximately 20 minutes. When the system was transferring files, it could not be disconnected and used for other applications. This meant that the x-ray technician could not begin the transfer process unless they were sure it would be completed before the workstation was required again. Although this was not a real issue during the pilot project (since the different aspects of the project were not tested in parallel) this will become an issue when the system is operational and the workstation is being used by more than one application.

In the event of an emergency, the x-ray technician locates the radiologist-on-call to inform them of an emergency. The read is done and a call is made back. The film is then processed in the manner described above.

9.1.4 Teledermatology

Teledermatology faced different problems than radiology because it was necessary to schedule patients, resources and the dermatologist. The process of running a "clinic" at a set time in each site proved to be successful. The following is the workflow for a dermatology consult:

1) The rural physician determines that a patient needs to consult a specialist.
2) The rural physician forwards patient history to the dermatologist.
3) The dermatologist determines that a consult is necessary.
4) The patient is scheduled either on a clinic day or at another time.
5) The workstation must be allocated at the rural site.

6) The workstation must be allocated at the consulting site.
7) The doctor or nurse must escort the patient into the clinic room and explain the technology.
8) The consult starts, typically the dermatologist and patient converse.
9) The dermatologist gathers more history, and pictures are requested.
10) The pictures are transferred to the dermatologist.
11) The dermatologist views the pictures and makes a diagnosis.
12) The dermatologist may follow-up with more questions.
13) The patient leaves.
14) The dermatologist dictates her report.
15) The report is faxed to the referring physician.

9.2 Organizational Design

This pilot project has clearly demonstrated that telemedicine is a human activity, not a technological event. Instead, the technology is the vehicle for enabling the delivery of healthcare services. For these reasons it is important to focus on operational and cultural issues - such as staff and patient perceptions and expectations, beliefs and motivation.

The overall program management must center on responding to users' needs; providing a constant flow of information; support and training; adapting the technology to the workplace; and providing staff and patients sufficient time to see the benefits of telemedicine.

9.2.1 Communications and Education

Key strategies must be developed to introduce telemedicine and teleradiology technologies into an existing environment. These include:

1) addressing staff and patients' concerns, particularly about confidentiality, privacy and the mobility of the equipment;
2) conducting awareness raising and induction activities as well as basic and advanced training;
3) consulting and providing users with adequate information about the aims of the project;
4) developing adequate operational documentation;
5) promoting the concept; and
6) providing feedback from evaluation surveys and research.

9.2.2 Clinical Needs Assessment

The clinical needs assessment is a process to identify the clinical areas that are of particular interest to a community or organization. This must be performed before the more detailed aspects of the program can be determined.

9.2.3 Workflow Analysis

Once clinical areas of interest have been identified the next step is to conduct a workflow analysis - to identify any processes currently in place, and any weaknesses in those processes. This will help resolve areas where new processes need to be developed to make the system functional, and allow it to flow smoothly.

9.3 Program Recommendations

The following are recommendations that result from experiences in the pilot project. All participants felt that it is necessary to have a program management infrastructure guiding and operating any operational telemedicine system.

9.3.1 Management Infrastructure

A telemedicine program must have a management infrastructure, with defined membership and responsibilities. Two aspects of such an infrastructure are described below.

1) A Telemedicine Advisory Board responsible for establishing policy decisions like acceptance of the strategic plan, patient acceptance, physician compensation, confidentiality, liability, and interdepartmental relationships within the government. The board would also help the Telemedicine Program Director focus on the future development and strategy for the growth of the program.

   Representation would include:

   ⇒ Department of Health
   ⇒ Tertiary care hospitals
   ⇒ Community hospitals
   ⇒ Dalhousie University Continuing Medical Education
   ⇒ Regional Health Boards
   ⇒ Clinical advisors
   ⇒ Patient representative

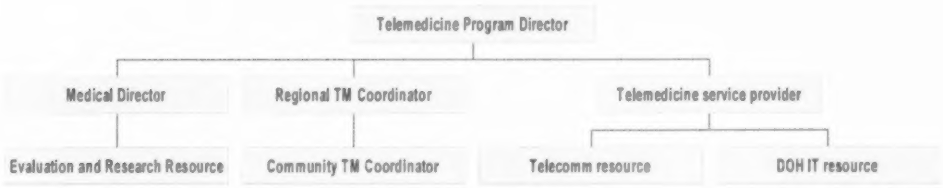
2) A Management Team which functions at arms length from the government and has the responsibility to:

   ⇒ Facilitate the establishment of province-wide telemedicine strategies, standards, policies, directions, applications, sites and priorities.
   ⇒ Monitor telemedicine program progress provincially, nationally and internationally in order to provide telemedicine clearinghouse information.

- ⇒ Develop short and long term telemedicine strategies in collaboration with the Department of Health and other stakeholders.
- ⇒ Assist stakeholders in developing and implementing the required changes in order that telemedicine can operate and flourish.

This management team should have the organizational structure shown in the following diagram.

Telemedicine Management Team



Job descriptions for each of the management team members are outlined below:

- ⇒ *Telemedicine Program Director:* Responsible for developing the strategic plan, implementation schedule, budget and communications plan for the Nova Scotia Health Link telemedicine network. The role reports directly to the Advisory Board for the telemedicine network and is accountable for the goals defined in the strategic plan and the management team.
  - The immediate supervisor would be the Chair of the Advisory Board, and would be responsible for supervising the Medical Director, Regional Telemedicine Coordinator, and Telemedicine Service Provider.
  - Manages internal relationships with Dalhousie University, QEII Health Sciences Centre, IWK Grace Health Centre, Department of Health, Medical Society, TecKnowledge Healthcare Systems, MT&T.
  - Manages external relationships with the Telemedicine Advisory Board, funding agencies, foundations and private sector partners, the media, Regional Health Boards, Referring and consulting sites, and Hospital CEO's and Facility Managers.
  - Duties: Overall responsibilities for the Nova Scotia Health Link network; manages the program budget; works with the telemedicine advisory board to ensure all program goals are being met; works with the media to ensure proper program promotion; works with government officials interested in telemedicine; coordinates the development of a clinical and technical audit tools to be used to measure network performance; coordinates interaction between rural sites and all participants; coordinates the growth of the network; visits participating sites on a regular basis; stays current on developments in the field of medicine; and establish strong linkages to the Department of Health.
- ⇒ *Medical Director:* Responsible for the clinical viability of the Nova Scotia Health Link Telemedicine network and ensuring that standards and practice guidelines are developed and implemented. This person is chosen from the

region as a physician who is respected amongst their colleagues in the region and reports directly to the Telemedicine Program Director.

- Immediate supervisor would be the Telemedicine Program Director, and would be responsible for supervising the Research and Evaluation resource.
- Manages internal relationships with the Dalhousie University Medical School, TecKnowledge Healthcare Systems, Department of Health.
- Manages external relationships with hospital Medical Advisory Committees, Regional Health Board Medical Directors', the Royal College of Physicians and Surgeons, and physicians in the region.
- Duties. Perform a clinical needs assessment at each of the referring and consulting sites in the region; liaison with the VP of Medical Services in the tertiary care hospitals; develop and implement clinical audit and evaluation tools; establish and implement clinical validation tools; provide input into the minimum technical standards; provide information and communication to the physicians; provide input on issues of patient confidentiality, security and privacy; resolve issues of reimbursement for physician services using the network; and establish utilization review and procedures for the system use.

⇒ *Regional Telemedicine Coordinator:* Responsible for the efficient operation, scheduling and ongoing support of the telemedicine network in the region. The person will have numerous part time community telemedicine coordinators requiring support and direction for the use of the network at their sites.

- Immediate supervisor would be the Telemedicine Program Director, and would indirectly supervise the community telemedicine site coordinators indirectly.
- Duties: Coordinates the day to day program schedule; acts as the liaison with his/her counterpart at each participating sites on a regular basis; maintains an on-call status, monitors all transmissions for data gathering purposes for evaluation and audit functions; travels to the participating sites to provide training, quality assurance and on going support; develops and maintains scheduling system for the network; liaisons with the Medical Director for issues around medical policy and procedures; and liaisons with the telemedicine service provider on issues around network acceptability and function.

⇒ *Telemedicine Service Provider:* Responsible for the network solution design and maintenance. The position is a project manager role and is responsible for implementation as well as ongoing change as the network expands. This person reports to the telemedicine Program director on all matters related to the technical aspects of the network.

- Immediate supervisor would be the Telemedicine Program Director, and would indirectly supervise resources supplied by the telecommunications provider and the Department of Health Information Technology resource.

- Duties: To deliver the implementation plan for the network on schedule; to ensure the future direction and needs of the Department of Health are being planned and considered; to ensure that the technical network is functioning according to the needs of the end users; to provide input to the technical audit and evaluation tools used by the management team; liaison with the telecommunications provider to ensure best use of the network; to ensure maintenance and upgrade of the network is provided on a timely basis; to implement technical changes as required by the clinical validation and audit requirements.

9.3.2 Staff

A number of staff should have system responsibilities incorporated into their ongoing job functions. The requirement for full or part time staff is wholly dependent on the planning and implementation processes established by the management team. The following are some of the recommended staff:

1) A Project Leader should be appointed to manage the overall acceptance of the program - including demonstrating the application of the technology on a practical basis, and training users in applications and uses.
2) Each clinical application must have a Clinical Leader. This is typically medical staff who have management and clinical responsibilities for an area. This person must have a strong desire to utilize the new technologies, and must lead others in their clinical area to adapting to the technology.
3) Each site must have a Telemedicine Coordinator to manage the daily routine of the telemedicine system. This includes scheduling, setting up conferences, moving the workstation to clinical sites within the facility, and solving system problems (administrative, technical and communication). This person is the first point of contact for the users at that site, and makes further contact with outside support services. The Telemedicine Coordinator also functions as the system trainer and will require training on system setup, use and troubleshooting and training in adult education and basic computer knowledge. This may require 5 days of off-site training for the Coordinator.
4) Telemedicine Service Provider. This person represents the telehealth service provider. The position is the project manager of the chosen vendor. Their role is to help make the necessary changes to the technical design of the network to ensures it expands and supports the changing needs.

9.3.3 Developing User Support

It must be recognized that there will be some resistance to the introduction of a new technology. This occurs for a number of reasons - including the normal work pressures of staff and their lack of experience with telemedicine. This will lead to limited motivation to use the proposed system. The best approach is to introduce telemedicine facilities incrementally and to win staff and patient support gradually.

It is extremely important to develop strategies to manage the concerns of the patients and staff, and to build their comfort in using the service. Possible steps toward this goal are:

1) activities to raise awareness - acknowledging the concerns of the users;
2) promoting the process through regular memos, newsletters, one-to-one and small group discussions;
3) providing information about project developments, such as the timing of installations and the provision of training;
4) presenting evaluation results directly to users;
5) consulting staff about decisions on issues that would affect them;
6) creating a structured staff development program; and
7) a series of demonstrations and special events.

It is also to find system champions to provide practical demonstrations of the benefits of using this new technology. Champions are the outstanding early users who deliberately providing leadership and example to their colleagues. The ongoing evolution of the system depends on the leadership of the champions.

9.3.4 Introduction and Training

Introduction and training sessions need to be undertaken in a number of stages:

1) Introduction to the philosophy and objectives of the project; technology components; infrastructure and overall system; and resources.
2) Training on the operation of the telemedicine conferencing capabilities, specific training on the operation of the peripheral devices and their clinical applications. Problem solving training, including power failures, equipment failures, recovery from failure, and communications problems.
3) On site support for the first week of clinical use.
4) Clinical validation and application development including optimizing the use of the workstation and devices in an application.
5) Introduction to the philosophy and objectives of the project; technology components; infrastructure and clinical validation and application development including optimizing the use of the workstation and devices in an application.

9.3.5 Documentation

It is essential that system documentation be developed and made available to system users. This includes operational and procedural documentation, along with equipment and system operation documentation. The following is a list of possible required documentation:

- List of Ethical Practices
- Policy and Procedures Manual
- Operating Instructions

- Patient Information
- System Changes and Updates
- System News

9.3.6 System Evaluation

It is essential to develop an evaluation component which will monitor progress for a pre-determined set of goals, and to manage ongoing evolution of the system. This process begins by establishing measurable, operational, technical and clinical goals.

9.3.7 Clinical and Technical Audit

A clinical and technical audit must be conducted on a scheduled basis, with the schedule created using Quality Assurance processes and underlying procedures.

9.3.8 User and Technical Support

It is necessary to augment on-site expertise with access to technical support. This support must be provided by an organization familiar with the technology, communication and application design and implementation. The primary contact will be through the on site telemedicine coordinator and the technical support provider.

Application and technical phone support should be accessible 7-days per week, 24-hours per day - as the network will be used for emergency triage cases. The phone support must be backed by a diagnostic and repair capability to ensure rapid solution to technical problems. The system should have the ability for rural technical access which will provide immediate technical support for the hardware and software by modem.

9.3.9 Maintenance and Upgrades

The service contract must include maintenance and upgrades of the system to ensure the network is working at its full capability. Technology and communications expertise should be accessed to maintain the operational status of the workstations and communications infrastructure.

9.4 Conclusions and Recommendations

Over the year long pilot project it became clear that any telemedicine program must be managed in a program management infrastructure to ensure most effective and efficient use of the technologies and the clinical and support resources. This is particularly important to the rural facilities who will have a single access point to the system - until usage dictates that a second access is reasonable.

It was also evident during the pilot project that a telemedicine system must have a strong administrative and technical support program to ensure that the systems are effectively and efficiently used. This includes managing the telemedicine workstation usage, and the quick resolution of technical and telecommunications problems.

The program management infrastructure recommended includes a Telemedicine Advisory Board and Telemedicine Management Team. The Telemedicine Advisory Board would be responsible for establishing policy decisions and strategic direction of provided telemedicine services. The Telemedicine Management Team would provide the overall management structure and facilitate the implementation and coordination of telemedicine programs. This would include establishing provincial, regional and local structures to ensure the highest degree of success for the overall telemedicine program.

10. Financial Assessment

10.1 Overview

A major objective of the pilot project was assess the financial viability of a multipurpose telemedicine workstation in a rural facility. This was based on an assumption that a multipurpose workstation would allow the sharing of capital and operating costs across a number of educational and clinical programs. This section reviews the project financing and results. Then, by using the results from the educational and clinical evaluations, costs of an expanded system are projected.

10.2 Project Costs

Project costs can be categorized as:

- project management costs of $27,500 to cover project management, administrative support, meeting expenses, travel expenses, and phone charges;
- program development and evaluation costs for the educational and clinical programs (summarized below); and
- capital and operational costs (summarized below).

The project completed all activities within the budget. This is primarily due to significant time and materials contributions made by all the partners, who contributed costs outside of their budget projections from their own resources.

10.2.1 Program Development and Evaluation Costs

Program development costs are those associated with the development and evaluation of educational and clinical programs. These are discussed below:

- Continuing Medical Education development costs were $37,000 and evaluation costs were $4,300. These funds were applied to developing the CME sessions, developing and conducting the evaluation, and preparing the evaluation report.
- Teleradiology development costs were $34,500 and evaluation costs were $12,500. These funds were applied to conducting an in-depth technical assessment, developing and conducting an evaluation program, and preparing the evaluation report. Radiologist consultation fees were paid under traditional fee-for-service guidelines.
- Dermatology development and evaluation costs were not budgeted for. Some of these have been covered as project management costs but most of this work was conducted using the internal resources of the partners. Dermatologist hourly consultation fees were covered under a separate agreement.

10.2.2 Project Capital and Operating Costs per Site

The following table summarizes the costs of establishing and operating each site. These costs matched those projected for the project.

QEII Consulting Site		
Workstation		
Capital (Telemedicine workstation, Digitizer, Reading Station)	$77,000	
Installation/Training	$2,500	
Support (24 hours/day, 7 days/week) per year	$7,700	/year
Communications (ISDN)	**1 line**	**2 lines**
Installation	$251	$502
Access (per month)	$125	$250
Long Distance (per minute)	$.35	$.70
Other		
56Kbps Frame-Relay Data Network (per month)	$500	/month
Conference Bridge (per hour)	$60	/hour

Cape Breton Regional Conferencing Site		
Workstation		
Capital (Room-based Videoconferencing)	$68,924	
Installation/Training	$3,000	
Support (24 hours/day, 7 days/week) per year	$5,000	/year
Communications (Sw-56)	**2 lines**	**4 lines**
Installation	$228	$455
Access (per month)	$180	$360
Long Distance (per minute)	$.35	$.70
Other		
Conference Bridge (per hour)	$60	$70

Dalhousie University Videoconferencing Room		
Other		
Room Rental	$150	/hour
Conference Bridge (per hour)	$60	/hour

Northside General Referring Site		
Workstation		
Capital (Telemedicine workstation)	$44,500	
Installation/Training	$3,000	
Support (24 hours/day, 7 days/week) per year	$4,500	/year
Communications (Sw-56)	**2 lines**	**4 lines**
Installation	$348	$695
Access (per month)	$180	$360
Long Distance (per minute)	$.35	$.70
Other		
Conference Bridge (per hour)	$60	/hour

Guysborough Referring Site		
Workstation		
Capital (Telemedicine workstation, Digitizer)	$76,500	
Installation/Training	$3,000	
Support (24 hours/day, 7 days/week) per year	$6,900	/year
Communications (Sw-56)	**2 lines**	**4 lines**
Installation	$348	$695
Network Construction		$10,000
Access (per month)	$180	$360
Long Distance (per minute)	$.35	$.70
Other		
56Kbps Frame-Relay Data Network (per month)	$500	/month
Conference Bridge (per hour)	$60	/hour

Eastern Shore Memorial Referring Site		
Workstation		
Capital (Telemedicine workstation, Digitizer)	$76,500	
Installation/Training	$3,000	
Support (24 hours/day, 7 days/week) per year	$6,900	/year
Communications (Sw-56)	**2 lines**	**4 lines**
Installation	$348	$695
Access (per month)	$180	$360
Long Distance (per minute)	$.35	$.70
Other		
56Kbps Frame-Relay Data Network (per month)	$500	/month

Conference Bridge (per hour)	$60 /hour

10.3 Continuing Medical Education Costs

This section identifies the operating costs of conducting the continuing medical education (CME) sessions during the pilot project. These are compared with the operating costs of providing (CME) by the traditional means. The final section projects these operating costs into an expanded model of delivering CME in this manner.

10.3.1 Provider Costs

In this section the costs of providing community CME programs via traditional means and by videoconferencing are compared. For illustrative purposes, two sites are chosen (Sydney and Guysborough) and the costs for each of these are identified.

Many community CME programs are given by "visiting professors". The traditional costs of these programs include honoraria, travel, possible costs of accommodations and meals, and the hidden costs to the specialist of loss of practice time. Faculty honoraria are based upon both the length of the CME program and the length of time which the faculty member must be out of town.

Traditional CME to two sites
Sydney and Guysborough (11/2 - 2 hrs)

Item	Sydney	Guysborough
Travel	$400	$180
Hotel	$100	$100
Honoraria	$500	$500
Total each site	$1000	$780
Combined total	$1780	

Notes Travel - by air to Sydney, by car to Guysborough (using Dalhousie University rate of $0.28/ km.)
Hotel - estimate including dinner and breakfast
Honoraria - $500 if overnight stay is required, $200 for programs less than two hours

Programs involving more than two sites require a videoconferencing bridge as a communications link. With the exception of a few programs, the costs of the videoconferencing bridge were included in an arrangement made when the room-based videoconferencing system was purchased for the Cape Breton Regional Hospitals. In fact, bridging costs range from $45 per hour per site to $70 per hour per site and, if high volume was anticipated, a conferencing bridge could be purchased or a flat-rate bridging service could be negotiated. For purposes of comparison a bridging cost of $60 per hour per site was chosen.

Other costs of videoconferencing CME include honoraria, studio rental, and long distance charges. It should also be noted that there would be negligible, if any, loss of practice time on the part of the specialist. It should also be noted that the faculty honoraria is less, as the faculty member is not out of town.

The following table provides cost details for a videoconference CME program broadcast to two sites simultaneously. Programs in the videoconference pilot project were 1.25 hours in length but for comparison with the traditional programs, costs for a 2-hour program are included.

The programs broadcast during the pilot project were restricted to a single ISDN line (or two SW-56) lines. Although most faculty and participants found this "acceptable" there was a preference expressed for improving the video and audio quality by increasing the telecommunications bandwidth. For illustrative purposes, the costs for both single and dual ISDN bandwidths are presented. Long distance charges are based on $0.35 per minute per ISDN line for each of the three sites (as all are dialing into the videoconferencing bridge).

Videoconference CME to two sites
Sydney and Guysborough

Single ISDN (2 channels)			Dual ISDN (4 channels)		
Expenses	**11/4 hr**	**2 hrs**	**Expenses**	**11/4 hr**	**2 hrs**
Studio rental	$150.00	$300.00	Studio rental	$150.00	$300.00
Long distance	$78.75	$126.00	Long distance	$157.50	$252.00
Conference Bridge	$180.00	$360.00	Conference Bridge	$180.00	$360.00
Honoraria	$200.00	$250.00	Honoraria	$200.00	$250.00
Total	$608.75	$1036.00	**Total**	$687.50	$1162.00

In summary, as shown in the previous section, a 1.5 to 2 hour traditional CME program presented in Sydney and Guysborough would cost approximately $1780. This compares to the cost of a 2 hour videoconferencing program of $1036 (single ISDN) or $1162 (dual ISDN). As the dual ISDN would be the preferred communications bandwidth, the saving per session is estimated at $618. If the 1.25 hr session is chosen the savings per session is estimated at $1092.5 ($1780 - $687.50).

10.3.2 Participant Costs

Physicians were asked to estimate the personal cost of attending traditional CME events. The following is a representative example of costs as estimated for physicians in the community of Guysborough to attend CME programs. It should be noted that registration fees are rarely charged for CME courses of 1 to 1.5 hours in length. The reason is that the bulk of these brief programs tend to be presentations of hospital medical departments or are sponsored by industry who absorb the costs to individual physicians. No tuition was charged for the videoconference CME programs during the pilot project.

1) CME is held in the nearest major town, Antigonish, 70 km away

⇒	2.00 hours	Travel time	
	1.25 hours	Seminar time	
	3.25 hours	Away from Office @ $100/hour for Lost Billing	$325.00
⇒	Travel expenses for 140 km @ $.27 a km		$37.80
⇒	Total expenses for 1.25 hr CME		$362.80

2) CME attendance in Halifax, 300 km away

⇒	6.0 hours	Travel time	
	6.0 hours	Seminar time	
	12.0 hours	Away from office 1 day @ $100/hour for Lost Billing	$800
⇒	Travel expenses for 600 km @ $.27 a km		$162
⇒	Total expenses for 6 hour CME (assuming 1 day/no accommodations)		$750

For the purposes of comparison with the videoconferencing CME pilot project, "Scenario 1" is the most useful. While attendance at a 1.25 hour CME program in Antigonish would cost a physician a total of $362.80, attendance at a 1.25 videoconference program in Guysborough would be at no or negligible cost. The latter requires no travel, and there is currently little need to miss office practice hours, as CME is generally scheduled outside regular hours - at 0730, 1200, or 1930 hours.

10.3.3 Participant Institution Costs

In order that provider and participant costs are realized, infrastructure must be in place to conduct videoconference sessions. The provider institution has the facility in place, and the costs of accessing that facility are identified in the program costs ($150/hour + long distance). In an effort to attribute all costs of providing CME via videoconferencing, it is necessary to amortize the capital costs of the system at the participant institutions. For illustrative purposes, the capital cost at the Northside General is used as it does not have teleradiology devices associated with it. The setup in the Cape Breton Regional Hospital was not used for comparative purposes as it was chosen for an urban site with larger numbers of participants.

Northside General Referring Site		
Workstation		
Capital (Telemedicine workstation)	$44,500	
Installation/Training	$3,000	
Support (24 hours/day, 7 days/week) per year	$4,500	/year
Communications (Sw-56)	**2 lines**	**4 lines**

Installation	$348	$695
Access (per month)	$180	$360
Long Distance (per minute)	$.35	$.70
Other		
Conference Bridge (per hour)	$60	/hour

The fixed costs of the system include capital ($44,500), installation/training ($3000) and communications installation ($695) for a total of $48,195. Fixing operating costs include support ($4500/year) and telecommunications access ($360/month) for a total of $8820. Other operating costs (long distance and conference bridge) are identified as operating costs for each program and are covered in the preceding sections.

CME is one of the primary uses of the system. If it is assuming that the system will be used for CME 25% of the time, then 25% of the fixed costs of the system should be attributed to CME. This can be estimated by amortizing the fixed costs of the system over a 3-year period (at a 7% effective interest rate), adding the fixed operating costs and finding 25% of those costs. This is summarized in the following table.

Cost	Total	Per Year	CME cost
Fixed	$48,195	$17,880	$4,470
Fixed Operating		$8,820	$2,205
Total			$6,675

Taking the provider saving per session $546 ($1092 between two sites for a 1.25 hr session), 12 sessions would have to be presented in that community to cover the CME portions of the costs, based on using the same model as in the pilot project (ie: only two receiving sites per session). Participant cost savings were not used in justifying the costs as they are lost income to the participant, not a savings to the healthcare system.

10.3.4 Summary

If only operational costs are taken into account, it seems that both providers and participants in CME programs benefit financially by have access to videoconferencing facilities in their communities. These results are determined on a session by session basis, so overall savings would increase as the number of sessions increases.

Using the pilot project model (2 receiving sites per session), 12 CME sessions must be held for the overall system to recover the fixed costs of installing this capability in each community (assuming a 25% usage for CME). Projecting this to sessions held with larger number of sites across Nova Scotia reduces the number of sessions necessary to recover capital costs. It is assumed that the costs of conducting a traditional CME session in each community is at least $750. (Guysborough at $780 and Sydney at $1000 are more distant than some other sites where CME might be provided.) It is also assumed that the CME sessions will be 1.25 hrs in length, and will be provided over a dual ISDN bandwidth.

A summary of this is shown in the following table. In this summary:

- long distance is calculated as the (# sites + provider site) @ $0.70/minute (dual ISDN);
- bridge costs are calculated as (#sites + provider) @ $60/site; and
- fixed costs are assumed at $6,675 per site.

Number of sites	**2**	**5**	**10**	**20**
Tradition Costs	$1,500	$3,750	$7,500	$15,000
Videoconference Costs				
Studio	$150	$150	$150	$150
Honoraria	$200	$200	$200	$200
Long Distance	$158	$315	$578	$1,155
Bridge	$180	$360	$600	$1,200
Total	$688	$1,025	$1,528	$2,705
Total Cost Difference	$812	$2,725	$5,972	$12,295
Cost Difference / Site	$406	$545	$597	$615
# Sessions to cover fixed costs	17	12	11	11

This table shows that approximately 12 session per site would have to be held in each site to recover the fixed costs attributed to CME. What is not accounted for in this costing model are the many indirect and non-tangible costs such as:

- The community is not "short" of physicians while they attend CME sessions in other locations. This should also reduce the need for locums.
- Physicians are able to receive more CME and facility accreditation would be reduced.
- Physicians are able to attend CME with their local peers. This is not possible in the traditional model, due to coverage considerations.
- Physicians are able to participate with their peers in other locations. This will reduce the feelings of isolation.
- Physicians will be able to "attend" sessions other than programmed CME - like grand rounds broadcast from teaching hospitals, conference sessions, etc.
- Other healthcare disciplines could also use the system to receive education and training (nursing, pharmacy, social workers, physiotherapists, etc.)

10.4 Teleradiology Costs

This section details the costs of a teleradiology service as identified during the pilot project. These are compared with the operating costs of traditional radiology. The final section summarizes the costs of delivering radiology services in this manner.

10.4.1 Consulting Radiology Costs

The consulting radiologist billed for services using the traditional billing mechanisms. The time taken per consult was longer than that for a typical film read. Some of this could be attributed to unfamiliarity with the system, and a need to streamline the processes. There is concern that radiologists, who generate income on a read-by-read basis, will lose income as the telemedicine reads take more time.

10.4.2 Consulting Institution Costs

Some operating costs were incurred to provide operating support to the teleradiology consultation process. This is primarily a result of the process for identifying patients and transcribing reports. Although there were incremental costs associated with this at the consulting institution, these costs would have been incurred if the radiology read had been conducted in the traditional manner.

In addition, the consulting institution will have costs associated with the equipment used to read the film images. This equipment should be resident in the radiology department, as it is specific to radiology services. As the QEII site costs include the radiology reading station along with the telemedicine workstation capabilities, it is necessary to estimate the costs for the teleradiology portion only. This is done by subtracting the fixed costs for the Northside site (telemedicine only), with that of the QEII site (telemedicine and teleradiology).

As previously shown, the costs for the Northside site were:

- The fixed costs of the system include capital ($44,500), installation/training ($3000) and communications installation ($695) for a total of $48,195.
- Fixing operating costs include support ($4500/year) and telecommunications access ($360/month) for a total of $8,820.

The costs for the QEII site were:

- The fixed costs of the system include capital ($77,000), installation/training ($2,500) and communications installation ($502) for a total of $80,002.
- Fixing operating costs include support ($7,700/year) and telecommunications access ($250/month), and network access ($500/month) for a total of $16,700.

This leaves a difference in fixed costs of $31,807 ($80,002-48,195), and fixed operating costs of $7,880 ($16,700-$8,820) which are associated with teleradiology only. The following costing estimate is based on the assumption that the fixed costs of the system are amortized over a 3-year period (at a 7% effective interest rate).

Cost	Total	Per Year
Fixed	$31,807	$11,880
Fixed Operating		$7,880
Total		$19,760

Therefore, the total annual fixed costs for the teleradiology reading station are $19,760. Note that there are no long distance charges associated with this system as the network provides the communications medium.

10.4.3 Referring Institution Costs

This section summarizes costs and savings with implementing a teleradiology system in a referring site. For purposes of calculation, it is assumed that Guysborough would send approximately 2000 films per year, and Sheet Harbour approximately 8,000.

Additional operational costs of implementing a teleradiology system in a referring site include technologist time to operate the teleradiology system (estimated at 1 minute/film) and increased phone line use for faxes and phone calls to the consulting site.

Savings would accrue from reduced film handling time for the technologist (sorting, labeling, packing, unpacking, retrieving, tracking and filing estimated at 0.5 minutes/film), reduced film handling time in the consulting site (receiving, delivering to radiologist, shipping estimated at 0.25 minutes/film), not having to pay to have films transported by bus, and savings accrued when patients are not transported due to ability to assess condition more specifically. The shipping/courier charges are estimated using the following as a basis:

- Guysborough: This facility pays a flat rate of $396 per month for transport of specimens, lab data, x-rays, etc. to Antigonish. It is estimated that this cost could be reduced by approximately 50% if the x-rays were not included. This gives the annual transport savings at $2,376.
- Sheet Harbour: This facility incurred costs of $276 during the 6 week pilot project. Projecting this to a full year (52 weeks) gives an annual cost of $2,392.

Operational costs and savings are summarized in the table below.

Operational Costs	Guysborough (2000 films)	Sheet Harbour (8000 films)
X-ray technician scanning ($15/hr, 1min/film)	$500	$2000
Fax/Phone Charges ($20/month)	$120	$120
Annual Operational Cost	$720	$2120
Operational Savings		
X-ray technician packaging ($15/hr, .5min/film)	$250	$1000

Film handling ($12/hr, .5min/film)	$200	$800
Shipping/Courier	$2,376	$2,392
Annual Operational Savings	$2,826	$4,192
Operational Savings	$2,106	$2,072

The costs of avoiding and emergency transport are estimated in the table below:

Emergency Transport Costs	Guysborough	Sheet Harbour
Ambulance transport	Halifax $486 Antigonish: $220	Halifax $220
Nurse attendant (minimum 8 hr shift)	$144	$144
Emergency Transport Avoided Cost Savings	Halifax $630 Antigonish: $364	Halifax $364

In addition, the referring institution will have costs associated with the equipment used to scan the film images. As the Guysborough and Sheet Harbour site costs include the teleradiology scanning station along with the telemedicine workstation capabilities, it is necessary to estimate the costs for the teleradiology portion only. This is done by subtracting the fixed costs for the Northside site (telemedicine only), with that of the Guysborough or Sheet Harbour sites (telemedicine and teleradiology).

As previously shown, the costs for the Northside site were:

- The fixed costs of the system include capital ($44,500), installation/training ($3000) and communications installation ($695) for a total of 48,195.
- Fixing operating costs include support ($4500/year) and telecommunications access ($360/month) for a total of $8,820.

The costs for the Guysborough and Sheet Harbour sites were:

- The fixed costs of the system include capital ($76,500), installation/training ($3,000) and communications installation ($695) for a total of $80,195.
- Fixing operating costs include support ($6,900/year) and telecommunications access ($360/month), and network access ($500/month) for a total of $17,220.

This leaves a difference in fixed costs of $32,000 ($80,195-$48,195), and fixed operating costs of $8,380 ($16,700-$8,820) which are associated with teleradiology only. The following costing estimate is based on the assumption that the fixed costs of the system are amortized over a 3-year period (at a 7% effective interest rate).

Cost	Total	Per Year
Fixed	$32,000	$11,880
Fixed Operating		$8,380
Total		$20,260

Therefore, the total annual fixed costs for the teleradiology sending station are $20,260. Note that there are no long distance charges associated with this system as the network provides the communications medium.

10.4.4 Summary

The estimated costs of a teleradiology system are summarized below.

Consulting Institution	
Amortized fixed costs	$19,760
Referring Institution	
Amortized fixed costs	$20,260
Operational savings	($2,376)
Total	$17,884

Using the costs and savings generated in the pilot project, a significant number of emergency transports (49) would have to be avoided to completely recover the costs for each referring institution. Also outstanding are the issues of payment of the specialist under the traditional billing model.

What is not accounted for in this costing model are the many indirect and non-tangible costs such as:

- Patients are able to more immediately access specialist expertise in the event of an emergency. This may reduce costs of inpatient stays while waiting for a radiology read on a film. (For example: A patient with pneumonia might stay in-hospital for extra days while waiting for the x-ray interpretation. A patient with a potential fracture, might be admitted to hospital for observation while waiting for the x-ray interpretation.)
- Patients are able to access specialist care in their own communities. In this way community resources are being supported - rather than community dollars being spent in consulting centers.
- Physicians are able to receive immediate assistance when faced with an urgent situation. This will reduce the feelings of isolation.

10.5 Teledermatology Costs

This section details the costs of conducting a dermatology clinic as identified during the pilot project. These are compared with the operating costs of traditional dermatology. The final section summarizes the costs of delivering dermatology services in this manner.

10.5.1 Consulting Dermatologist Costs

The dermatologist billed for consultations and follow up visits based on codes used by MSI for 1996, as follows:

Consultation type	Code	# of patients
Major consultations	C001	23
Minor consultations	C002	31
Continuing care	C004	11

The rates are the same as would have been charged for the patients' visits if they had been seen in the dermatologist's office as opposed to by teledermatology.

The time taken per consult was longer than that a typical office visit. Some of this could be attributed to unfamiliarity with the system, and a need to streamline the processes. There is concern that dermatology specialists, who generate income on a visit-by-visit basis, will lose income as the telemedicine clinic takes more time.

10.5.2 Consulting Institution Costs

Minor operating costs were incurred to provide operating support to the teledermatology consultation process; e.g. scheduling of patients, faxing and organizing patient documentation, typing reports, managing charts, etc. Most are similar to those in a traditional dermatology consulting practice, except that more time is required for co-ordination between the consulting site and referring site(s). It is estimated that for a two-hour clinic, these processes would require about one-half hour clerical time (about $7).

In addition, the consulting institution will have costs associated with the equipment used to receive the consult. This equipment might be resident in the dermatology department, or may be shared with other departments - depending on volume. For illustrative purposes, the capital cost of the system at the Northside General in North Sydney is used as it does not have teleradiology devices associated with it, and is very close to the set-up used for consulting purposes.

As previously shown, the costs for the Northside site were:

- The fixed costs of the system include capital ($44,500), installation/training ($3000) and communications installation ($695) for a total of $48,195.
- Fixing operating costs include support ($4500/year) and telecommunications access ($360/month) for a total of $8820.
- Long distance costs are not included as they are typically paid by the referring site.

The following costing estimate is based on the assumption that the fixed costs of the system are amortized over a 3-year period (at a 7% effective interest rate) and that there are 2000 available hours/year (50 weeks @ 40 hours/week). Therefore, a 2-hour dermatology clinic would then be 1/1000 of the amortized cost. This is summarized in the following table.

Cost	Total	Per Year	Clinic cost
Fixed	$48,195	$17,880	$17.88
Fixed Operating		$8,820	$8.82
Total			$26.70

Therefore, the total consulting institution costs of a 2-hour clinic would be for clerical support ($7) plus the amortized capital costs ($26.70).

10.5.3 Patient Costs

The traditional dermatology consult for patients in Guysborough and Sheet Harbour requires the patient to travel to the specialists in Halifax. This is also true for North Sydney, as receiving an appointment with a Halifax specialist (waiting time of about eight weeks) is often preferable to waiting the six-month time period to see the sole dermatologist in Sydney. Costs to the patient include direct transportation expenses, indirect travel expenses such as meals and child care, and time lost from work.

Guysborough is a 3.5 hour drive from Halifax (about 280 km), meaning that a brief appointment in Halifax requires about seven hours of travel time by car. Sheet Harbour is about two hours away from Halifax (about 150 km.), requiring a total of four hours travel by private car. However, the bus leaves Sheet Harbour at 09:30 and does not leave Halifax to return until 17:00, to arrive back home at 2000. The cost with meals is about $60. North Sydney is a five hour drive from Halifax (about 440 km), and as these patients came from different areas in Cape Breton, their actual travel distance could exceed this. These figures are summarized in the table below:

Patient travel costs by community

Community	Distance to Halifax	Direct travel expenses @ $.27 per km (gov't rate)	Indirect travel expenses
Guysborough	280 km	$151 (car)	Meal/s, parking, time off work, child care, etc. Could also include overnight expenses (North Sydney)
Sheet Harbour	150 km	$81 (car) $60 (bus)	
North Sydney	440 km	$238 (car) $120 (bus) $60 (shuttle)	

As is evident from this table, the patient is faced with significant costs to visit with a specialist. This is not normally a healthcare system cost, except with some patients who are funded by the Department of Social Services.

10.5.4 Referring Physician Costs

In two of the three referring sites, the dermatology clinics were conducted by the referring physicians (Guysborough and Sheet Harbour). During the trial these physicians were not reimbursed for their attendance at the clinic. This followed the funding model for a traditional specialist consult - where a referring physician would not normally attend.

Most referring physicians felt that attendance at the clinics was beneficial and educational but that they were taking time away from their office to attend. This resulted in lost income and could become a concern if the number of specialist services provided through telemedicine increased. The possibility of funding needs to be further explored, along with the possibility of receiving continuing medical education credits for attendance at telemedicine specialist clinics.

10.5.5 Referring Institution Costs

Costs to the institution include provision of operating and support services - such as patient booking, registration, telemedicine equipment operation and patient support (if the referring physician chooses not to accompany the patient). The largest component of these would be for patient support, provided by a registered nurse. For example, the registered nurse in North Sydney is a senior nurse who is paid at the rate of $24 per hour (including benefits at 15%), or a 2-hour clinic would incur costs of approximately $29.60.

The cost of the receptionist's time in OPD in North Sydney for booking and registering patients was not taken into account, as she booked teledermatology patients along with patients for other clinics. As this involved phoning the patients, it could be estimated that one-half hour a week is required to book four patients during a two-hour clinic. This time and cost could also be applied to the receptionists/ secretaries of the referring physicians in Sheet Harbour and Guysborough. At an hourly rate of $12 hour (including), this would be about $7 per clinic.

In addition, the referring institution will have costs associated with the equipment used to conduct the clinic. As this equipment is multipurpose, its use is shared with other programs (CME, teleradiology, etc.) For illustrative purposes, the capital cost of the system at the Northside General in North Sydney is used as it does not have teleradiology devices associated with it, and is very close to the set-up used for the dermatology clinic.

As previously shown, the costs for the Northside site were:

- The fixed costs of the system include capital ($44,500), installation/training ($3000) and communications installation ($695) for a total of $48,195.
- Fixing operating costs include support ($4500/year) and telecommunications access ($360/month) for a total of $8820.
- Long distance costs are estimated for an enhanced communications bandwidth of three ISDN lines. During the pilot a single ISDN line was used. Although this was

found to be marginally acceptable, most participants in the trial felt that an enhanced audio and video would greatly enhance the clinical capability.

The following costing estimate is based on the assumption that the fixed costs of the system are amortized over a 3-year period (at a 7% effective interest rate) and that there are 2000 available hours/year (50 weeks @ 40 hours/week). Therefore, a 2-hour dermatology clinic would then be 1/1000 of the amortized cost.

Cost	Total	Per Year	Clinic cost
Fixed	$48,195	$17,880	$17.88
Fixed Operating		$8,820	$8.82
Total Fixed			$26.70
Communications		$63/hr	$126.00

Therefore, the total consulting institution costs of a 2-hour clinic would be clerical support ($7.00), the amortized capital costs ($26.70), long distance costs ($126.00), and nursing assistance where applicable ($29.60)

10.5.6 Summary

In summary, the patient has the highest cost savings in this model. The estimated costs of a two hour clinic are summarized below.

Consulting Institution

Amortized fixed costs	$26.70
Clerical support	$7.00
Total	$33.70

Referring Institution

Amortized fixed costs	$26.70
Clerical support	$7.00
Long distance charges	$126.00
Total	$159.70

Also outstanding are the issues of payment of the specialist under the traditional billing model, and compensation for referring physicians.

What is not accounted for in this costing model are the many indirect and non-tangible costs such as:

- The knowledge in that specialty area is increased at the referring site. This is particularly true if the referring physicians participate in the clinics.
- Patients are able to access specialist care in their own communities. In this way community resources are being supported - rather than community dollars being spent in consulting centers.
- Patients may incur costs saving much higher than noted as the costs of child care and time off work were not estimated.

10.6 Conclusions and Recommendations

Costs of a telemedicine program are relatively easy to identify and rationalize, but cost savings are difficult to both identify and estimate. This pilot project demonstrated that justifying the total costs of implementing a telemedicine program from operational savings alone will be difficult. Using technologies which are multipurpose shares the fixed costs among a number of educational and clinical applications.

It was found that that variable operational costs of providing CME using videoconferencing technologies were significantly less than those of providing traditional CME programs. This did not include the savings to rural physicians and facilities by reducing the requirements for travel and time away, or the capital and fixed operating costs of the workstations.

The operational savings realized in providing teleradiology services were found to be relatively small in comparison to the capital and fixed operating costs of the service. Using the model provided in the pilot project, a significant number of emergency admissions or transports would need to be avoided to recover these costs. It is difficult to estimate the overall financial impact of providing more rapid turn-around of radiology reports but it is projected that savings would be the result of more immediate and accurate treatment of patients.

The patient realized the largest savings in the teledermatology services. This was due to reduced requirements for travel. Using the pilot project model, the estimated costs of providing a two hour teledermatology clinic were estimated at $33.70 for the consulting institution, and $159.70 for the referring institution. This included an estimate of the amortized fixed costs of the workstation in each of the facilities.

A telemedicine program is effective in moving the provision of clinical services from an urban community to a rural community. This will have a financial impact on the rural community and the healthcare facilities in those communities - but this impact is difficult to measure. It is also difficult to determine the savings that will result from more immediate response to clinical problems, and better access to specialist services by rural patients. This should improve the health status of those communities and reduce the overall long term healthcare costs.

11. Conclusions and Recommendation

The pilot project was successful in its goal of assessing the educational, clinical, technical, operational and financial viability of a telemedicine program in providing support to rural communities. The telemedicine program tested during this pilot project was found to be educationally, clinically and technically viable. It was determined that a telemedicine program needed to be established in a program management infrastructure to allow for cost rationalization by merging the requirements of education and training, clinical programs and administrative activities in rural facilities.

A summary of the conclusions and recommendations of each component of the pilot project can be found in each of the individual sections. In addition, the Executive Summary compiles all of this summary and recommendation information and presents it in a concise format.

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